DOCUMENT RESUME

ED 167 715 CE 018 615

AUTHOR Hinrichs, Roy S., Comp.
TITLE Electricity-Electronics for Industrial Arts. Instructors Lesson Plans. Industrial Arts Series, Publication Number 10,010.
INSTITUTION Mississippi Research and Curriculum Unit for Vocational and Technical Education, State College.
SPONS AGENCY Mississippi State Dept. of Education, Jackson. Div. of Vocational and Technical Education.
PUB DATE 76
NOTE 120p.; For a related document see CE 018 613

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS Behavioral Objectives; *Electricity; *Electronics; *Industrial Arts; Learning Activities; Occupational Information; Safety; School Shops; Secondary Education; Transparencies; *Vocational Education
IDENTIFIERS *Mississippi

ABSTRACT

Thirty-one lesson plans on electricity-electronics are presented in this guide designed for industrial arts instructors. Each lesson plan is organized into the following format: (1) lesson objective; (2) supplementary teaching items; (3) presentation; (4) demonstration; (5) laboratory or other activities; and (6) test items (oral, written, or performance). Lesson plans are organized into seven topics: safety; the language of electricity-electronics (e.g., wiring diagram symbols); electrical tools, materials, and processes; electrical principals (e.g., Ohm's law, magnetism); sources of electrical energy (e.g., static electricity, thermocouples); producing and storing electricity (capacitors, transformers); and career occupations in electricity-electronics. Thirty-two transparency masters conclude the document. (JH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED167715

Electricity - Electronics for Industrial Arts

Instructors Lesson Plans

Sponsored by the

Division of Vocational and Technical Education
Mississippi State Department of Education
Jackson, Mississippi

Compiled by

Roy S. Hinrichs
Associate Professor
Mississippi State University

Published by the

Mississippi State University
Research and Curriculum Unit
for
Vocational and Technical Education
Mississippi State, Mississippi

Industrial Arts Series
Publication Number 10,010

1976

CE 018 645

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

R. S. Hinrichs

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND THE ERIC SYSTEM CONTRACTORS."

Direct Inquiries to:

Research and Curriculum Unit for
Vocational-Technical Education
Drawer DX
Mississippi State, Mississippi 39762

Mississippi State University does not discriminate on the grounds of race, color, religion, sex, or national origin.

ACKNOWLEDGMENTS

Much of the material included in this publication was adopted and/or modified from an instructional guide developed by the Instructional Materials Laboratory, University of Missouri - Columbia.[1] Appreciation is extended to that laboratory for sharing their excellent materials.

Acknowledgements are extended to Mr. Robert D. Brook, Instructor, Mississippi State University for help during the planning stage of the manual. Also to Mr. Frank Malone, Graduate Assistant presently teaching electricity-electronics in the Industrial and Occupational Education department, a special thanks for suggestions concerning content selection and format of these materials.

Appreciation is also extended to Miss Julie McKibben, artist/illustrator, R/CU, for many of the transparency drawings appearing in the publication.

---

[1] Fundamentals of Electricity/Electronics, Instructional Materials Laboratory, Department of Practical Arts and Vocational-Technical Education, University of Missouri - Columbia, 1972.

AUTHENTICATION COMMITTEE

The material in this publication was reviewed and endorsed as being appropriate and beneficial for inclusion in the industrial arts curriculum by an authentication committee. Deep appreciation is extended to the members for their time and valuable suggestions.

Mr. Larry Anderson
Industrial Arts Instructor
Henderson Junior High School
Starkville, Mississippi

Mr. Larry L. Godfrey
State Supervisor
Industrial Arts Education
Jackson, Mississippi

Mr. Frank Malone
Electricity-Electronic Instructor
Industrial and Occupational
Education Department
Mississippi State University

Mr. Art D. Nabers
Assistant Supervisor
Industrial Arts Education
Jackson, Mississippi

TABLE OF CONTENTS

		Page
Acknowledgments		i
Authentication Committee		ii
Transparency Masters Table		v
Objectives		vii
How To Use the Material		viii
Lesson Number		
	SAFETY	
1	Safety - Shop Practice & Procedures	1
2	Effect of Electrical "Shock"	4
3	Emergency Situation Procedures	7
	THE LANGUAGE OF ELECTRICITY-ELECTRONICS	
4	Introduction to Electrical Terminology	10
5	Wiring Diagram Symbols	12
6	Component Identification	14
7	Basic Color Code	16
8	Types of Conductors and Insulators	18
	ELECTRICAL TOOLS, MATERIALS AND PROCESSES	
9	Electrical Tools and Materials	20
10	Soldering Techniques	23
	ELECTRICAL PRINCIPLES	
11	Introduction to Ohm's Law	26
12	Application of Ohm's Law	28
13	Resistance of a Single Source DC Series Circuit	30
14	Resistance of a Single Source DC Parallel Circuit	32
15	Principles of Continuity Testing	34
16	Characteristics of Open and Closed Circuits	36
17	Magnetism	38
18	Electromagnets	41
	SOURCES OF ELECTRICAL ENERGY	
19	Static Electricity	43

		Page
20	Cells and Batteries	45
21	Secondary Cells	48
22	Thermocouples	50
23	Solar Batteries	52
24	Piezoelectricity	54
	PRODUCING AND STORING ELECTRICITY	
25	Capacitors	56
26	Transformers	58
27	Direct-Current Generators	61
28	Principles of an AC Generator	63
29	Basic Motor Action	65
30	Producing and Transmitting Electricity	67
	OCCUPATIONAL INFORMATION	
31	Career Opportunities in Electricity-Electronics	69

TRANSPARENCY MASTERS TABLE

		Page
EE1	Objectives	72
EE2	Capacitors in Parallel and in Series	73
EE3	(A) Pictorial View of Parallel-Connected Cells. .	74
	(B) Schematic of Parallel Connections	74
EE4	(A) Pictorial View of Series-Connected Cells . .	75
	(B) Schematic of Series Connection	75
EE5	Different Size of Conductors	76
EE6	Basic Hand Tools	77
EE7	Soldering Technique	78
EE8	Summary of Basic Formulas	79
EE9	Simple Electric Circuit (Closed - Open)	80
EE10	Circuit Pictorial.	81
EE11	Bell Circuit	82
EE12	Magnetic Poles	83
EE13	Reaction Between Charged Bodies	84
	Electrostatic Lines of Force	84
EE14	Magnetic Field Produced by a Current-Carrying Coil	85
EE15	Left-Hand Rule for Coil Polarity	86
EE16	Producing Static Electricity by Friction	87
EE17	Simple Voltaic Cell.	88
EE18	Cutaway View of the General-Purpose Dry Cell . . .	89
EE19	Type-B Hydrometer	90
EE20	Lead-Acid Cell	91
EE21	Lead-Acid Battery	92
EE22	Voltage Produced by Heat	93

		Page
EE23	Solar Cell	94
EE24	Generation of Electricity	95
EE25	Four-Pole Basic AC Generator	96
EE26	Right-Hand Motor Rule	97
EE27	Self-Inductance	98
EE28	How Electric Energy is Used	99
EE29	The Generation And Transmission of Electricity .	100
EE30	A Step-Down Transformer	101
EE31	A Step-Up Transformer	102
EE32	Water Powered Generator	103

OBJECTIVES

The overall objectives for this nine weeks instructional program in the area of electricity-electronics are to:

1. Develop insights and basic understandings of electricity-electronics and its place in our culture.
2. Discover and develop talents, attitudes, interests and individual potential related to electricity-electronics.
3. Develop abilities in the proper use of tools, machines and processes used in electricity-electronics.
4. Develop an understanding of a variety of careers, their requirements, training availability and future employment opportunities in electricity-electronics.
5. Develop safety consciousness and favorable attitudes toward electricity-electronics.

NOTE: Transparency master No. 1 contains the above objectives. You may wish to use this transparency during student orientation to the electricity-electronics area.

HOW TO USE THE MATERIAL

This material has been developed to assist you in conducting an electricity-electronics instructional program for a time frame of approximately nine weeks. The intent was to provide basic information on electricity-electronics suitable for an industrial arts multi-field laboratory teaching situation.

The material has been developed using a lesson plan format and is geared to the text Understanding Electricity and Electronics.[2] It is essential that you obtain a copy of this text for your use, and preferably sufficient copies for all students enrolled in the course. In the upper right hand corner of each lesson plan, the reference cited is to this text.

The text provides ample instructional material for a full year's course, therefore, no attempt should be made to "teach it all" in nine weeks. In addition to the basic information on electricity-electronics, supplemental suggestions on experiments are included that can be performed by students. These experiments require only inexpensive materials usually found in the industrial arts laboratory. Many of these experiments are included in the lesson plans under LABORATORY OR OTHER ACTIVITIES.

No industrial arts program can be successful if restricted only to classroom work or only to laboratory activities. Successful programs usually include a blend of approximately fifty percent classroom work and fifty percent laboratory activities. Keep this in mind when plan-

---

[2]Buban and Schmitt, Understanding Electricity and Electronics, McGraw-Hill Book Company, New York, 1969.

ning your program. In addition to the experiments mentioned above, other laboratory activities should be planned using the SUGGESTED PROJECTS found at the rear of the text. Other references can be used as a source for additional take home project ideas.

Conducting an electricity-electronics program using the lesson plans included will require preparation. Begin by familiarizing yourself with the material in the text as cited by the reference on each lesson plan. Next examine the lesson plan carefully. The format for each lesson plan included the following:

1. Lesson Objective
2. Supplementary Teaching Items
3. Presentation
4. Demonstration
5. Laboratory or Other Activities
6. Test Items

Your major concern will be gathering the materials necessary for demonstrations, student activities, and preparing the presentation. Introductory statements are provided for the presentation, plus an outline to follow.

Thirty-one lesson plans are presented in this publication. It may be necessary to eliminate some due to time limitations, lack of equipment and supplies, or the capabilities of your students. Be flexible and make adjustments as necessary.

The transparency masters included in the rear of this publication have been duplicated and placed in a packet for your convenience. Properly prepared and used, these visual aids will strengthen your presentation. If recommended for use with a particular lesson plan, these will be noted under SUPPLEMENTARY TEACHING ITEMS.

Other materials which would be helpful in conducting your program are mentioned in the publication Resource Information for Industrial Arts.[3] These materials include R/CU 16mm loan films, free instructional material from industry, and reference books.

Do not overlook the lesson plan entitled CAREER OPPORTUNITIES IN ELECTRICITY-ELECTRONICS. Occupational information of this type is desirable and beneficial in any industrial arts program. No student should exit from a course such as this without knowledge concerning career opportunities in the electricity-electronics industries, employment outlook for the future, training required for entry, or how and where training is available. The teacher who provides such information to his/her students is fulfilling one of the important objectives of industrial arts.

[3]Hinrichs and Stone, Resource Information for Industrial Arts, Research and Curriculum Unit, Mississippi State University, 1976.

Reference pp. 33-34, 40, 270-271

Lesson No. 1

SAFETY-SHOP PRACTICE AND PROCEDURES

LESSON OBJECTIVE:

The student will be able to demonstrate safe shop practices and procedures to be used in the electricity/electronics laboratory. He shall also be able to demonstrate corrective action to take in the event of emergency situations (fire or electrical shock).

SUPPLEMENTARY TEACHING ITEMS:

1. Pliers (insulated and non-insulated)
2. Safety posters (usually available from local power companies)
3. Modified extension cord (see demonstration page)

PRESENTATION:

Safety should be an important concern to all individuals, Not only for one's own protection, but also your co-workers. Today you will be shown hazards which exist in the electricity/electronics laboratory, as well as what action to take in the event of an accident or emergency. Remember, safety is no accident. An unconcern for safety may lead to an accident, injury, or fatality.

A. Tour the classroom and/or laboratory and point out:

   1. Work hazards and safety devices.
   2. Location and use of fire extinguishers.
   3. Location of electrical switches, circuit breakers and/or fuse panel.
   4. Location of fire exits.
   5. Safety zones and painted safety areas.

B. Report unsafe conditions such as:

   1. Worn insulation or equipment
   2. Obstructions or blocked exits
   3. Wet floors
   4. Missing or broken extinguishers

C. When working with live circuits:

   1. Insulated foot pads are recommended
   2. Wear non-conductive shoes
   3. If possible, de-energize the circuit (turn it off.)

4. Use insulated tools
5. Handle "hot" circuits with one hand in pocket
6. Double check and "know" your circuit at all times
7. Do not use "lead" pencils in or on electrical circuits (graphite is a conductor)
8. Ground electrical equipment if possible (utilize 3 prong plugs).
9. Observe the National Electrical Code and local electrical codes

D. Safety posters are excellent reminders and warnings. Utilize them in the electricity/electronics laboratory.

E. Closure

You have been shown the location of the main switches, exits, and fire extinguishers along with safety precautions and action to be taken in the event of an emergency. Remember them for they can be useful not only here in class, but also outside of class.

DEMONSTRATION:

Modify an extension cord by removing one wire from the plug, leaving about 1/2" of the wire uninsulated.

1. Plug cord into wall receptacle.

2. Connect the bare wire end to drain or water pipe. (If necessary reverse plug to cause lamp to light.)

3. If possible contact the wire on a moist concrete floor to show conductivity of floor.

LABORATORY OR OTHER ACTIVITIES:

Assignment: Have the students make a sketch of the laboratory location of switches, fire extinguisher, first aid manuals, exits, etc. The sketches should be placed in each student's file to show that safety instructions were given to each student.

Personal Protection Policies

1. Do not work on electrical apparatus with wet hands or while wearing wet clothing.

2. Do not wear clothing with exposed metal zippers, or buttons.

3. Do not wear thin soled shoes with metal plates or shoes with nails on soles.

4. Do not touch electrical circuits with "lead" pencils. (They are made of carbon which is highly conductive.)

5. Gasoline, ether, or alcohol should not be used near electrical equipment.

6. Carbon tetrachloride should never be used on fires or as a cleaning solvent.

7. Stand on insulated mats when working with electrical circuits.

TEST ITEMS: (Oral, Written or Performance)

1. What type (A, B, or C) fire extinguisher should be used on an electrical fire? Why?

2. Why is it possible to make a lamp light when utilizing only one terminal of the receptacle?

3. In an electrical emergency you must turn off the power. Where is the main switch (circuit breakers, or fuse box) located and how is the power turned off?

4. What should be done if an electrically unsafe condition is discovered?

5. Why is it possible to get "shocked" when standing on a concrete floor?

6. What should you do if another student is involved in an electrical accident?

Reference pp. 33-34, 40, 270-271

Lesson No. 2

EFFECT OF ELECTRICAL "SHOCK"

LESSON OBJECTIVE:

The student will be able to:

1. Demonstrate and explain the variation in body resistance between various parts of the body.
2. Explain the observable effects of electrical "shock" on the body.
3. Explain or demonstrate safe practices when working with electrical apparatus.

SUPPLEMENTARY TEACHING ITEMS:

Safety Posters (usually available from local power company)

PRESENTATION:

The effect of electrical shock on the human body is a concept that everyone working with electricity should understand. The resistance of one's body to current flow determines the severity of electrical shock. Individuals working with electrical circuits must be aware of potential shock hazards and knowledgeable in first aid for electrical shock victims.

I. Effects of electrical shock on the body

A. Muscular spasm - cannot control muscles to turn loose of shocking electrical source. Can break bones.

B. Breathing stops - no oxygen into blood stream

C. Heart stops beating - no blood circulation

D. Unconsciousness - falling can cause other injuries

E. Burns - these are deep into the muscles, long healing also destroys muscles

F. Destruction of nerve tissues - inability to move muscles

G. Current (not voltage) is the determining critical factor:

1. 1 milliampere (0.001 ampere), shock can be felt
2. 10 milliampere (0.01 ampere), muscles are paralized - unable to release electrical source
3. 100 milliampere (0.1 ampere), shock fatal if duration is 1 second or more

II. Body Resistance

A. Dry skin - high resistance (low current)

B. Moist skin - low resistance (high current)

C. Amount of body (surface) contact (more surface contact, lower the resistance)

III. Current Path Effects

A. Through fingers of same hand (injury only to hand)

B. Through body (hand-body-foot route) - (more body damage)

IV. Secondary Effects of Shocks

Involuntary reaction: (examples)

1. Bumping objects or individuals in the immediate vicinity
2. Falling from ladders or other high places

V. Closure

The knowledge of the effects of electricity on the human body may help save a life.

DEMONSTRATION:

1. Show the variation of body resistance among members of the class.
2. Simulated shock can be demonstrated by pressing or manipulating the nerve (funny bone) in the elbow.

LABORATORY OR OTHER ACTIVITIES:

The student can measure the resistance between:

1. His hands

2. A foot and one hand

3. Two wet hands

4. Tongue and hand, etc.

TEST ITEMS: (Oral, Written or Performance)

1. List four main safety rules to be observed when working with electricity.

2. What amount of amperage is considered enough to be fatal?

3. What practices can be used to reduce electrical shock?

4. What difference would it make in the path electrical current takes through an electrical shock victim?

Reference pp. 33-34, 40, 270-271

Lesson No. 3

EMERGENCY SITUATION PROCEDURES

LESSON OBJECTIVE:

The student will be able to explain and/or demonstrate the correct procedures to initiate in the event of an emergency situation involving:

a. electrical shock
b. injury
c. fire

SUPPLEMENTARY TEACHING ITEMS: (Aids, Drawings, Tools, Materials, etc.)

1. Safety posters available from local power company, National Safety Office, etc.

2. Demonstrations by local fire, law enforcement or Red Cross Agencies.

3. R/CU Safety Films

PRESENTATION:

In spite of safety precautions, emergency situations may develop from time to time. The main point of this lesson is to acquaint students with emergency first aid procedures involving shock, injury, or fire. Proper first aid training could result in saving one's life.

A. Explain emergency procedure;
   1. Action in the event of fire
      a. Sound the alarm
      b. Attempt to extinguish
      c. Evacuate the building
      d. Notify proper authority
   2. Electrical shock
      a. Turn off power
      b. Check for breathing and heartbeat
      c. Administer first aid (according to local policy)
      d. Treat for shock
   3. Artificial Resuscitation
      How soon administered

B. Explain local shop rules

1. Reasons for clean shop
2. Use of flammable materials
3. A "no nonsense" business
4. Reporting of classroom accidents

C. Closure

During this class we have studied instructions on what to do in emergency situations.

DEMONSTRATION:

I. Mouth-to-mouth resuscitation may be demonstrated by any of the following means.

A. Film
B. Local Red Cross Chapter
C. Local Heart Association
D. Local law enforcement agency
E. Local fire fighting agency

II. Fire prevention and protection

A. Overloaded circuit (lightweight wire with heavy load)
B. Use of fuses and circuit breakers
C. Use of fire extinguisher

LABORATORY OR OTHER ACTIVITIES:

1. Local fire drill procedures

2. Have the students react to a "shock accident" situation.

"The Accident Victim"

Arrange for the class to be out of the laboratory (such as on a tour). During their absence set up an "emergency" situation so that when the class returns they find an individual lying on the floor, holding an electrical tool in his hand. The intent here is to represent an electrical shock situation.

The class would be expected to respond by applying the correct first aid procedures in the proper sequence. Suggested items for observation are:

1. Disconnect power source (or remove victim from exposure)

2. Check for heartbeat
3. Check for breathing
4. Artificial Resuscitation (simulated)
5. Treat for shock
6. Call for medical assistance (simulated)
7. Report accident (simulated)

Note: This test may be administered on an individual basis throughout the term. It can be administered unexpectedly from time to time.

TEST ITEMS: (Oral, Written or Performance)

1. To whom and when should classroom accidents be reported?

2. What kinds of fire extinguishers may be used on an electrical fire?

3. What action should be taken when an accident victim has stopped breathing?

4. How should electrical circuits be protected from overload?

Reference pp. 428-431 Lesson No. 4

INTRODUCTION TO ELECTRICAL TERMINOLOGY

LESSON OBJECTIVE:

The student will be able to explain the meaning of the following terms; volt, ohm, resistance, current amperage, alternating current, direct current, power supply, hot or live circuit, resistor, conductor and insulator.

SUPPLEMENTARY TEACHING ITEMS:

Instruction sheets containing terms and definitions listed below should be prepared for pass-out to students.

PRESENTATION:

To be knowledgeable in a technical field such as electricity-electronics it is essential to understand the related technical terminology. This class session will present several technical terms as a basis for better understanding and further pursuit in the electrical field.

I. Explain the following terms:

A. Volt - electrical pressure - unit of measurement of that pressure.
B. Current - the flow of electrical energy or electrons through a conductor.
C. Ampere - (AMP) the unit of measurement of current (the amount of current flow.)
D. Resistance - the opposition to the flow of current.
E. Ohm - the unit of measurement of resistance to current flow.
F. Conductor - A material (usually copper) which allows "electricity" to flow freely.
G. Insulator - substance which does not allow current flow.
H. Resistor - a device which restricts (but does not stop) the flow of current.
I. Direct Current - (DC) a condition in which the current flows in only one direction. (Example: battery)
J. Alternating Current - (AC) a condition in which current flows alternately in opposite directions along a conductor. Example: household current.
K. Hot - a term used to signify that the electrical apparatus is on or energized.

L. Power Supply - a source of electrical power other than the wall outlet. It may be a device which plugs into an outlet or a battery. They may be AC or DC.

II. Closure

This lesson has added some new terms to your technical vocabulary. As we go along further in the course, and gain more knowledge of the subject, we shall refine or improve these definitions to be more technically correct.

(Note to Instructor)

This lesson has been designed to explain the basic terms the student needs to understand early in the course. The definitions of these terms are expressed in a non-technical manner in order to provide an easily understood reference point from which more advanced technical definitions may be developed.

DEMONSTRATION:

A demonstration is not planned for this lesson.

LABORATORY OR OTHER ACTIVITIES:

No additional activities planned for this lesson.

TEST ITEMS: (Oral, Written or Performance)

1. What is the relationship between resistance, resistor and ohm?

2. An energized electrical apparatus is often called _____.

3. A _____ allows current to flow while a _____ does not allow current to flow.

4. A source of electrical power other than a wall outlet is called a _____.

5. When current flows in one direction only it is _____.

Reference pp. 16, 109, 117-119 Lesson No. 5

WIRING DIAGRAM SYMBOLS

LESSON OBJECTIVE:

The student will be able to identify and interpret symbols used in electrical wiring diagrams.

SUPPLEMENTARY TEACHING ITEMS:

Transparencies No. EE2, EE3, EE4

PRESENTATION:

Up to this point we have been looking at components in pictorial view. You have discovered the difficulty in making a pencil sketch of a circuit using pictorial designs. To simplify the drawing of a circuit diagram, a standardized symbol identification has been developed and is used world-wide. Today we shall look at these symbols to see what they represent and how they are used.

I. Display and explain symbol transparencies

A. Capacitors
B. Resistors
C. Transformers
D. Switches

II. Closure

We have seen that it can be difficult to draw pictorial diagrams of the electrical components which are used. A simple world-wide uniform system of symbols is part of the electrical worker's "language."

DEMONSTRATION:

No additional demonstration planned for this lesson.

LABORATORY OR OTHER ACTIVITIES:

1. Have the students draw and identify electrical symbols discussed in class.

2. Show electrical components for the students to observe and identify by drawing the appropriate symbol.

TEST ITEMS: (Oral, Written or Performance)

1. Draw the symbols for the following electrical components:

   a. carbon resistor
   b. iron core transformer
   c. switch
   d. electrolytic capacitor

2. What is the difference (if any) in the symbol for a disc/ceramic and a tubular capacitor?

3. Identify the symbol for a transformer and state its type of core.

4. What does an arrow represent on a capacitor or transformer symbol?

Reference pp. 14-17, 20-25 Lesson No. 6

COMPONENT IDENTIFICATION

LESSON OBJECTIVE:

The student will be able to recognize and identify electrical components from pictorial diagrams and arrange these parts according to a circuit diagram.

SUPPLEMENTARY TEACHING ITEMS:

1. Schematics
2. Assortment of electrical components (resistors, capacitors, transformers, diodes, transistors, etc.)

PRESENTATION:

There are many different types of electrical components. It becomes necessary, therefore, that students be able to recognize these parts. Today we shall look at several components and place them according to a circuit diagram.

I. Component identification

- A. Capacitors
- B. Resistors
- C. Switches
- D. Transformers
- E. Diodes
- F. Transistors

II. Explain circuit arrangement

III. Closure

This layout practice should give the student a good idea of how different components "fit" into electrical circuits.

DEMONSTRATION:

A. Introduction

B. Show and identify

1. Capacitors

   a. molded
   b. tubular
   c. ceramic
   d. electrolytic

2. Resistors

   a. carbon
   b. wire wound
   c. potentiometers

3. Transformers

   a. filament
   b. I.F.
   c. power
   d. output

4. Diodes

5. Switches (various)

C. Show relationship in circuit diagram

LABORATORY OR OTHER ACTIVITIES:

Hand out a pictorial diagram and have each student assemble the circuit as shown.

TEST ITEMS: (Oral, Written or Performance)

From the parts setting on the table, select and identify the following components:

1. Disc/ceramic capacitor
2. Iron core transformer
3. Carbon resistor
4. Tubular capacitor
5. Diode

(Written) - Draw the symbol for a

1. Switch
2. Bell
3. Buzzer
4. Motor
5. Lamp

Reference p. 414 Lesson No. 7

BASIC COLOR CODE

LESSON OBJECTIVE:

The student will be able to: (1) identify and select resistors of various ohmic values, and (2) identify the tolerance limits of selected resistors.

SUPPLEMENTARY TEACHING ITEMS:

Color Code charts (obtain at any electronics supply store)

PRESENTATION:

Each occupation has its own means of measurement. The carpenter has his ruler of inches and feet, the cook uses cups and spoons, and the butcher uses pounds and ounces. Electrical work also has its own set of measurements; however, the "things" that are measured are impossible to see. The carpenter can look at an unmarked board and identify it as a 2 x 4 or a 1 x 6, but the electrician cannot look at an unmarked resistor and give its value. The value can be measured with a meter, but this can be quite a chore. It would seem logical to mark the values on the resistors, but writing large value numbers on a small size resistor is not always possible. Some other means of identification must be used.

The system used to identify the value of a resistor is called color coding. Color coding at first may be difficult to learn, but with a little practice the students will be able to identify resistor values very accurately and rapidly.

I. Display color chart

A. Explain color values

B. Explain the first three color bands and markings

C. Work sample "readings"

II. Closure

We have seen that it is not practical to print the numerical values on most resistors. Therefore, a color code system is used. We have "read" ohmic values using this color system and seen how it works.

DEMONSTRATION:

A. Show color code chart for 4 band system (using several resistors) and explain:

   1. The first band
   2. The second band
   3. The third band

B. Show color code for radial lead resistors

   1. Body
   2. End
   3. Dot

C. Three band color system

   1. First band
   2. Second band
   3. Third band

LABORATORY OR OTHER ACTIVITIES:

Using a color code chart and various size resistors have the students "read" the ohmic values of these resistors. (Tolerances will be covered in a later lesson.)

TEST ITEMS: (Oral, Written or Performance)

(Written) Explain the meaning of each of the first three bands of a four banded resistor.

(Performance) Lay out 10 resistors and by using the color code have the student identify the resistor values.

Reference pp. 43-52 Lesson No. 8

TYPES OF CONDUCTORS AND INSULATORS

LESSON OBJECTIVE:

The student will be able to identify stranded and solid conductors, as well as insulators and insulating materials.

SUPPLEMENTARY TEACHING ITEMS:

1. Several pieces of wire, solid and stranded
2. Transparency No. EE5
3. Different sizes of conductors

PRESENTATION:

Basically there are two types of wires used in electrical work. The two are stranded and solid. A stranded conductor is made up of many small "solid" conductors, whereas a solid wire consists of only one solid strand. The applications of each are unique so it is essential for one to understand these applications.

I. Difference between insulators and conductors

A. Common wires and cords

1. Wire shapes
2. Wire coverings
3. Magnet wire
4. Buss bar
5. Miscellaneous conductors

B. Insulating materials

1. Wood
2. Liquids
3. Glass
4. Porcelain
5. Rubber
6. Asbestos
7. Mica
8. Plastic

C. Types of electrical tape

1. Friction
2. Rubber
3. Plastic

4. Varnished cambric

II. Closure

DEMONSTRATION:

Note: Display a piece of solid and a piece of stranded hook up wire; show the difference and advantages of each by bending each back and forth several times. The stranded wire will not break as quickly as the solid wire.

1. Display various types of conductors pointing out the variation in insulation from one to another.
2. Display of numerous insulators and characteristics of each such as voltage rating, etc.

LABORATORY OR OTHER ACTIVITIES:

No activities planned for this lesson.

TEST ITEMS: (Oral, Written or Performance)

1. List three common insulators.
2. What is the most economical and practical conductor?
3. Why are both stranded and solid wire produced?
4. What type of wire is used for lamp cords? Why?

Reference pp. 43-49, 70-77, 96-106

Lesson No. 9

ELECTRICAL TOOLS AND MATERIALS

LESSON OBJECTIVE:

The students shall be able to identify and explain the purpose of basic hand tools and materials used in the electricity/electronics laboratory.

SUPPLEMENTARY TEACHING ITEMS:

1. Basic hand tools used in the shop

    a. pliers (longnose, diagonal cutters, utility)
    b. screwdrivers (Phillips, blade type)
    c. nut drivers
    d. miscellaneous (wire gauge, wire strippers, crimping tools)

2. Material

    a. types of wire
    b. electrical tape
    c. socket plugs
    d. test leads
    e. terminal clips connectors

3. Soldering devices

    a. guns
    b. pencils
    c. irons
    d. various types of solder

4. Transparency No. EE6

PRESENTATION:

In order for a person to be a proficient worker he must be familiar with the tools and materials which he will be using. An individual armed with this knowledge not only establishes an air of confidence within himself, but also creates a professional image in the minds of those about him. During this class students will identify and discuss the tools and materials common to electricity/electronics laboratories and the electrical trades.

I. Name and explain the uses of:

    A. Selected electrical tools
    B. Selected electrical materials

II. Have the students inspect and associate the names of the tools and materials

A. Tools
   1. Pliers
      a. long nose
      b. diagonal cutters
      c. utility
   2. Screwdrivers
      a. Phillips
      b. Keystone
      c. Allen
   3. Nutdrivers
   4. Miscellaneous
      a. crimping tool
      b. wire strippers

B. Material
   1. Types of wire
   2. Cheater cords
   3. Spaghetti
   4. Connecting leads (test leads, clip leads)
   5. Terminal clips and connectors

C. Soldering devices
   1. Guns
   2. Pencils
   3. Irons

DEMONSTRATION:

The tools listed below are suggested items. You may add, delete, or change according to your own situation and classroom condition.

Demonstrate the use and purpose of the following:

a. diagonal cutters - (to cut wire, not bolts)
b. wire strippers
c. screwdriver types
d. solding devices
e. wire gauge
f. connecting leads
g. test leads
h. various terminals and connectors

LABORATORY OR OTHER ACTIVITIES:

Students will observe and discuss display set-ups of electrical tools and materials.

TEST ITEMS: (Oral, Written or Performance)

1. What are the basic types of screwdrivers that were discussed in class?

2. Why is it important that one use the proper size screwdriver for the job?

3. What are some of the "don'ts" pertaining to the use of diagonal cutters?

4. What determines the type of soldering device to use for a particular job?

Reference pp. 95-98 Lesson No. 10

SOLDERING TECHNIQUES

LESSON OBJECTIVE:

The student will be able to make mechanically strong and electrically sound joints by soldering copper wire, component leads and/or terminal strips.

SUPPLEMENTARY TEACHING ITEMS:

1. Soldering tools (iron, gun, pencil, etc.)
2. Solder
3. Terminal strips
4. Wire
5. Transparency No. EE7

PRESENTATION:

We have been talking about electrical components and their purposes in electrical applications. In order for these components to perform in the intended manner they must be connected into the circuit mechanically strong and electrically sound. Today we shall discuss the elements in the art of soldering, followed by a demonstration and practical applications.

I. Show samples of good soldered joints

- A. Component to terminal strips
- B. Component to component
- C. Component to tube sockets
- D. Wire to components

II. Explain tools and materials

- A. Soldering devices
  1. Gun
  2. Iron
  3. Pencil
  4. Methods of testing soldering tools
- B. Types of solder
  1. Solid core
  2. Acid core
  3. Rosin core

III. Procedure for Soldering

- A. Tinning wire
- B. Clean surfaces

C. Mechanical connection
D. Heat sinks
E. Use of soldering gun (iron)
F. Application of solder
G. Cooling

IV. Closure

Soldering is not only an art but it is also an essential technique of the trade. Your ability to make a good joint will not only insure sound circuitry, but will represent the trademark of your workmanship.

DEMONSTRATION:

A. Explain and show tool uses

1. Soldering gun
2. Soldering pencil
3. Testing soldering equipment

B. Connection procedures

1. Cleaning wires
2. "Tinning" wires
3. Making connection

C. Technique

1. Use of heat sinks
2. Applying heat
3. Applying solder
4. Cooling

LABORATORY OR OTHER ACTIVITIES:

Note: Have the student solder components to terminal strips. As they progress have them connect wires between the terminals as shown by a simple schematic. Have them use their ingenuity to lay out a neat circuit utilizing the fewest number of connecting wires. (In other words, use the leads of the components to make the connections between the components.)

Have students perform the following:

1. "Tin"

a. Solid wire
b. Stranded wire

2. Solder

a. Electrical components
b. Terminal strips

TEST ITEMS: (Oral, Written or Performance)

1. What type of core solder (and/or flux) should be used for electrical component soldering?

2. Why should cold solder joints be avoided?

3. What can be done to correct a cold solder joint?

4. What problem does heat from soldering devices pose for circuit components? How can this be avoided?

5. List the steps in tinning a wire?

Reference pp. 144-146 Lesson No. 11

INTRODUCTION TO OHM'S LAW

LESSON OBJECTIVE:

The student will be able to state the relationship of current, voltage and resistance according to Ohm's Law.

SUPPLEMENTARY TEACHING ITEMS:

1. "PIE" Diagram
2. Battery
3. Resistors
4. Lamps
5. Switches
6. Conductors
7. Transparency No. EE8

PRESENTATION:

The relationship between voltage, current and resistance was first determined by George Simon Ohm, a German physicist. This relationship is commonly known as Ohm's Law. In this lesson we will discuss this relationship between current, voltage and resistance.

I. George Simon Ohm

His work

II. Ohm's Law

Relationship of current, voltage, resistance

Current increases if voltage increases when resistance is held constant, etc.

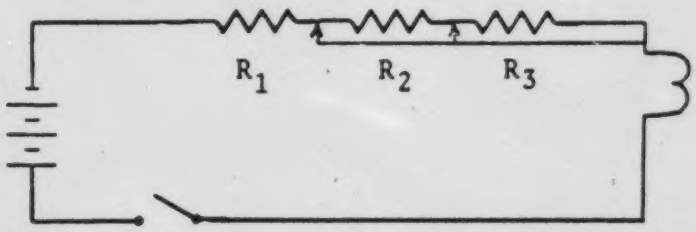
III. $I = \frac{E}{R}$

A. I (current
B. E (voltage)
C. R (resistance)

DEMONSTRATION:

Construct the circuit as shown on the following page and vary the resistance by shunting across R1 and R2.

Explain how a change in resistance with voltage held constant causes a change in current.



(The brightness of the lamp indicates amount of current flow.)

LABORATORY OR OTHER ACTIVITIES:

Let students repeat the demonstration.

TEST ITEMS: (Oral, Written or Performance)

1. Explain the relationship of voltage, current and resistance.
2. State Ohm's Law in terms of the resistance being inversely proportional to the current, etc.
3. Explain the reason for the change in current when there is a change in resistance (voltage held constant).

Reference pp. 144-416 Lesson No. 12

APPLICATION OF OHM'S LAW

LESSON OBJECTIVE:

The student will be able to work simple resistance, current and voltage problems using Ohm's Law.

SUPPLEMENTARY TEACHING ITEMS:

Chalkboard

PRESENTATION:

Many electrical circuit calculations are made through the use of Ohm's Law. The understanding of this law is essential to the circuit designer and servicing personnel alike. During this class we shall apply Ohm's Law to various electrical circuits.

I. Introduction

II. Explain the "meaning" of Ohm's Law

A. Show symbols used

1. Ohm
2. Ampere
3. Volt

B. Work sample problems

1. Solve for I
2. Solve for E
3. Solve for R

III. Conduct demonstration "showing" the calculated results

IV. Closure

Your understanding of Ohm's Law will be very useful to future electrical experiences. Review it often to insure that you understand its application.

DEMONSTRATION:

A. After working sample problems, compare the calculated values with measurement of:

a. Voltage
b. Current
c. Resistance

B. Show that by knowing any two values of Ohm's Law that a third value may be calculated.

C. Using the Ohm's Law formula, explain what happens to the current and resistance when the voltage is changed.

D. Give a practical example utilizing the Ohm's Law formula.

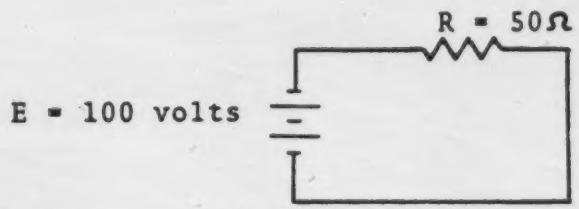
LABORATORY OR OTHER ACTIVITIES:

Students are to work problems using Ohm's Law. Assign problems, solving for the missing quantity.

Given:			Solve for:
	a.	E & I	R
	b.	R & E	I
	c.	I & R	E

TEST ITEMS: (Oral, Written or Performance)

(Written) Calculate the value for I when E and R are known.



Reference pp. 146-150 Lesson No. 13

RESISTANCE OF A SINGLE SOURCE DC SERIES CIRCUIT

LESSON OBJECTIVE:

The student will be able to identify a series circuit and explain the resistive relationship in the circuit.

SUPPLEMENTARY TEACHING ITEMS:

1. Power source
2. Connecting leads
3. Load (light, resistor, etc.)

PRESENTATION:

All electrical circuits have resistance of some nature. In the various circuits these resistances have different relationships as we shall see in the study of electrical circuits. In the case of a series circuit the total resistance is equal to the sum of the individual resistors of that circuit. We will analyze this statement further by breaking down a series circuit into its basic parts.

I. Definition of a Series Circuit

A. Recognition of a series circuit

Components utilized in a series circuit

B. Resistance of a series circuit

1. Circuit load (resistance)
2. Circuit containing one resistance (load)
3. Circuit containing two resistors (loads)
4. Circuit containing two or more resistors (loads)
5. Resistance in a series circuit (distributed R)

II. Closure

DEMONSTRATION:

Set up a series circuit with several resistances and measure these resistances to show additive effect of resistance in a series circuit.

LABORATORY OR OTHER ACTIVITIES:

Solve in class a problem involving series circuit resistance. Students set up series circuits and measure the resistance of these circuits.

Place three of the same size resistors of about 1,000 ohms or less in series. Have the student read and take note that resistors add in a linear fashion when connected in series. The circuit should consist of three different size resistors, but not more than 50% or so difference. (example; a 220 ohm, 330 ohm, and 470 ohm resistors.)

TEST ITEMS: (Oral, Written or Performance)

1. What is a series circuit?

2. Explain how you can recognize a series circuit?

3. What is the relationship of the resistances in a series circuit?

Reference pp. 146-150 Lesson No. 14

RESISTANCE OF A SINGLE SOURCE DC PARALLEL CIRCUIT

LESSON OBJECTIVE:

The student will be able to:

1. Identify a parallel circuit
2. Explain the resistance relationship of the circuit
3. Calculate the resistance of a simple parallel circuit.

SUPPLEMENTARY TEACHING ITEMS:

1. VOM
2. Power source
3. Connecting leads
4. Load (lights, resistors, etc.)
5. String of parallel Christmas tree lamps

PRESENTATION:

Like the series circuit the parallel circuit has basic laws which govern its operation. However, the laws of a parallel circuit are quite different from those of a series circuit. We will review the law of parallel circuit resistance. It states that the total resistance of a parallel circuit is less than any one of the individual resistances contained within that circuit.

The parallel circuit resistance can be explained by the following:

A set amount of current can flow through a specific resistance with a fixed amount of voltage applied. When a second resistance path is provided, current can now flow in two paths thereby increasing the total circuit current. If current increases while voltage remains fixed the resistance has to decrease.

I. Definition of a parallel circuit

II. Recognition of a series circuit (Components utilized in a parallel circuit)

III. Resistance of a parallel circuit

A. Circuit load (resistance)
B. Circuit containing one resistance (load)

C. Circuit containing two resistances (loads)
D. Circuit containing two or more resistances (loads)

IV. Closure

DEMONSTRATION:

Connect an ohmmeter across a resistor and set to a range that gives approximately a midscale reading. Connect another resistor of the same size as the first across the first resistor. Note that the resistance is cut in half. Next place another resistor of the same size parallel with the other two. Now the resistance reading is 1/3 of the first.

Next take a 1,000 ohm resistor and read the resistance with an ohmmeter. Connect a 100 ohm resistor across the 1,000 ohm resistor, and before reading with an ohmmeter ask the students to calculate the expected value.

LABORATORY OR OTHER ACTIVITIES:

Students should set up parallel circuits and measure resistance of these circuits as resistors are added. Also calculate the amount of resistance to compare values.

Have them measure the total circuit resistance of the Christmas tree lights while removing one lamp at a time and note the change.

TEST ITEMS: (Oral, Written or Performance)

1. What is a parallel circuit?

2. Explain how you can recognize a parallel circuit.

3. What is the relationship of resistance in a parallel circuit?

Reference pp. 247-251 Lesson No. 15

PRINCIPLES OF CONTINUITY TESTING

LESSON OBJECTIVE:

The student will be able to explain the principle of continuity testing.

SUPPLEMENTARY TEACHING ITEMS:

1. Insulated wire
2. Wiring harness

PRESENTATION:

One of the most common tests made in electrical work is the continuity test. This is a simple and quick test which proves to be very reliable. Such a test can be made with simple devices such as a buzzer and battery or light and battery, as well as an ohmmeter.

A continuity test determines if there is a continuous electrical path between two points in an electrical device. Obviously, if no continuous path exists, the circuit is open. Thus, the ohmmeter may be used to locate open circuits, switches, filaments, etc.

I. Discuss the concept of continuity testing

II. Devices used in continuity testing

   A. The idea of a continuous path
   B. Readings: on an ohmmeter indicating continuity or no continuity

III. Closure

DEMONSTRATION:

Note: Prepare, before the class, a piece of insulated wire that has insulation, but has a break in the wire. The continuity test proves the wire is open while a visual inspection would indicate a sound conductor.

1. Continuity between two points.

2. Continuity testing with a light and battery, or a buzzer and battery and the ohmmeter. (Use a piece of wire on which to perform this test.)

3. Point-to-point testing on some simple electrical device such as a lamp cord or an electric element, etc.

LABORATORY OR OTHER ACTIVITIES:

The student should be provided with a device to make continuity tests and an electrical apparatus on which to perform these tests. (i.e. leads, a long piece of wire, lampcords, or microphone cable with connectors attached, etc.)

Make wiring harness using ten 18" pieces of insulated bell wire tied together at the center with a knot.

1. Identify continuity of wires in lamp cord.

2. Identify continuity of wires in a wiring harness.

TEST ITEMS: (Oral, Written or Performance)

1. A continuity test is most often made with an _____.

2. A circuit having a loose connection or broken wire is called an _____.

3. Two common circuit defects which are easily identified by a continuity test are _____ and _____.

Reference pp. 247-252 Lesson No. 16

CHARACTERISTICS OF OPEN AND CLOSED CIRCUITS

LESSON OBJECTIVE:

The student will be able to explain and detect open and closed circuits.

SUPPLEMENTARY TEACHING ITEMS:

1. Transparencies No. EE9, EE10, EE11
2. Batteries 1.5v
3. Lamps #39
4. Connecting leads
5. Lamp sockets

PRESENTATION:

We have seen how meters and other indicating devices are used in continuity tests. In this lesson we will utilize these devices to detect open and closed circuit conditions. An open circuit may be described as a break in the circuit that prevents the flow of electrical current. A closed circuit is a complete path through which electrical current may flow.

I. Describe the following

   A. Open circuit
   B. Closed circuit

II. Show meter reactions to:

   A. Open circuit condition
   B. Closed circuit condition

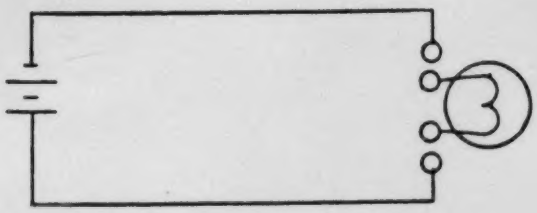
III. Closure

In service work the technician must be able to test for and recognize open and closed circuit conditions. During these tests personal safety and equipment precautions must always be exercised.

DEMONSTRATION:

1. Connect battery and lamp in a series circuit as shown on page 37.
2. Touch connecting leads to the light terminals and explain a closed circuit.

3. Remove the wire and explain why the light goes out.



LABORATORY OR OTHER ACTIVITIES:

No student activities planned for this lesson.

TEST ITEMS: (Oral, Written or Performance)

1. A closed circuit describes a condition when a light is "on." (T or F)

2. An open circuit is a completed electrical path. (T or F)

Reference pp. 164-169 Lesson No. 17

MAGNETISM

LESSON OBJECTIVE:

The student will be able to:

1. Recognize various types of magnets.
2. Describe the materials of which magnets are made.
3. Explain the law of magnetic attraction and repulsion.

SUPPLEMENTARY TEACHING ITEMS:

1. Various artificial magnets
2. Transparencies No. EE12, EE13
3. Overhead projector
4. Iron filings
5. Transparent material

PRESENTATION:

Any substance which will attract metals such as iron, steel, nickel and cobalt are magnetic in nature and the substance is considered to be a magnet.

Permanent magnets are used in electric clocks, door latches, compasses as well as other less important applications. Electromagnets are used in electric motors of all types, ignition systems, magnetic chucks and control circuits.

I. Define a magnet

II. Magnetic poles

- A. Law of repulsion and attraction
- B. Lines of force

III. Types of materials for magnets

- A. Natural (loadstone, magnetite)
- B. Permanent (steel)
- C. Electromagnet (soft iron)

IV. Shapes of magnets

A. Horseshoe
B. Bar
C. Round
D. Ceramic
E. Plastic

V. Methods of making magnets

A. Stroking a needle with a magnet
B. Electromagnetism

VI. Destroying magnetism

VII. Closure

Permanent magnets are important and have many applications. Therefore, a further understanding of magnetism is necessary. Next we should investigate the basic properties of permanent magnets.

DEMONSTRATION:

To show magnetic effects, a couple of novelty "dog" magnets purchased from a local variety store can liven up the class and bring home the points of polarity, attraction and repulsion quickly.

Stroke a bar magnet with a steel knitting needle to show how a magnet can be produced. (Pick up tacks to demonstrate magnet.)

A method for showing the magnetic lines of force of various magnets is to place a magnet on the overhead and cover with a transparent material. Next sprinkle iron filings over the top of the magnet. (Tapping the glass will aid the filings to align themselves.) This process will give an excellent pictorial effect of the magnetic lines.

LABORATORY OR OTHER ACTIVITIES:

1. Suspend a bar magnet so it can swing freely to verify laws that the south pole of a magnet seeks a northerly direction.

2. Suspend two bar magnets close together but not touching to verify the law that like poles repel, unlike attract.

3. Place a bar magnet on a table and place a cardboard or paper over the magnets. Sprinkle iron filings on top of the paper. Tap the paper gently, note and draw the pattern formed.

4. Place two bar magnets with like poles close together on a table. Place a piece of cardboard or paper on top of the magnets. Sprinkle iron filings on the paper. Tap the paper gently, note and draw the pattern formed.

TEST ITEMS: (Oral, Written or Performance)

1. List five basic shapes of magnets.

2. Soft iron is most suitable for use in a

   a. Permanent magnet
   b. Natural magnet
   c. Temporary magnet
   d. Magnet

3. Like poles will

   a. Attract
   b. Repel

4. Unlike poles will

   a. Attract
   b. Repel

Reference pp. 173-181 Lesson No. 18

ELECTROMAGNETS

LESSON OBJECTIVE:

The students will be able to:

1. List and briefly describe the advantages of electromagnets over permanent magnets.

2. Describe the operation of the electric bell, relays, magnetic current breakers, telephone and door bells.

SUPPLEMENTARY TEACHING ITEMS:

1. Doorbells
2. Relays
3. Autohorns
4. Magnetic circuit breakers
5. Electric clutch
6. Speaker
7. Transparencies No. EE14, EE15

PRESENTATION:

Electromagnets have numerous applications which are important in our everyday life. The electric bell, door bell, electric brakes, relays of many kinds, magnetic circuit breakers and electric clutches are only a few of their common applications. Several advantages of electromagnets over permanent magnets include: (1) the ease with which their strength can be varied; (2) their fabrication to specification for various physical size and magnetic strength; and (3) the capabilities of being turned on and off.

I. Advantages of electromagnets

II. Briefly discuss electromechanical devices including

- A. Electric bell
- B. Relays (auto horns, auto starter circuit)
- C. Magnetic circuit breakers
- D. Electric clutch
- E. Speaker
- F. Simple telephone
- G. Doorbells
- H. Magnetic starters for electric motors

III. Closure

With the many applications of electromagnets, it is important that a good understanding of these devices be acquired.

DEMONSTRATION:

There are many different kinds of electromagnetically operated devices which should be demonstrated such as buzzer, a door bell and a solenoid starter switch. You can also show how a battery across a speaker voice coil causes the cone to move in and out as the polarity of the battery is reversed.

Show the action of a solenoid valve for water control in an automatic washer. (Note: no mechanical linkage, hence no problem with leaky seals or gaskets.)

LABORATORY OR OTHER ACTIVITIES:

Have the student perform the following:

In Understanding Electricity and Electronics, perform job #25, p. 179; job #26, p. 179; job #27, p. 181. (Note: use low voltage #39 bulb with 6 volt source.)

TEST ITEMS: (Oral, Written or Performance)

1. What are the advantages of electromagnets over permanent magnets?

2. Given several illustrations of electromagnetic devices, describe how each one functions.

3. Explain how a simple electric bell operates.

Reference pp. 116-121 Lesson No. 19

STATIC ELECTRICITY

LESSON OBJECTIVE:

The student must be able to:

1. Explain how static electricity is produced.
2. List the practical application of static electricity and describe each.
3. Explain the theory of static electricity.

SUPPLEMENTARY TEACHING ITEMS:

Transparency No. EE16

PRESENTATION:

Electricity that is at rest or where a current cannot flow is referred to as static electricity. "Static" means "not moving." This situation occurs when two bodies of matter have unequal electrical charges and an electrical force is exerted between them.

Static electricity has been considered a nuisance in the past but is now being utilized in some areas such as painting, air filtering, and production of abrasives. Efforts are being made to apply this source of energy to other areas of everyday living.

I. The atom and its components
   - A. Electron
   - B. Neutron
   - C. Orbits of the atom
   - D. Free electrons

II. Static electricity
   - A. Charged bodies
   - B. Coulomb's law of change
   - C. Electric field

III. Methods of producing static electricity

IV. Application of static electricity

V. Closure

DEMONSTRATION:

1. Use a balloon and a wool sweater to demonstrate the production of static electricity.

2. Two pith balls (or two balloons suspended by thread) and a hard rubber rod rubbed with wool may be used to demonstrate the law of charged bodies.

LABORATORY OR OTHER ACTIVITIES:

The student should perform:

1. Job 3, pp. 119-120 in Understanding Electricity and Electronics.

2. Job 4, pp. 120-121 in Understanding Electricity and Electronics.

TEST ITEMS: (Oral, Written or Performance)

1. Static electricity is often produced by:

   a. Pressure
   b. Magnetism
   c. Heat
   d. Friction

2. List four applications of static electricity.

Reference pp. 208-212, 217 Lesson No. 20

CELLS AND BATTERIES

LESSON OBJECTIVE:

The student will be able to:

1. Define common battery terms for a primary cell
2. Explain the characteristics of primary cells
3. List the disadvantages of primary cells

SUPPLEMENTARY TEACHING ITEMS:

Transparencies No. EE17, EE18

PRESENTATION:

Early studies in electricity were done with what is known as a cell. These cells are connected to form batteries which is one of the several sources for electrical energy today. Electrochemistry is a very fascinating study, however, quite complex.

Batteries are used every day in automobiles, flashlights, toys, missiles, space vehicles, portable radios, and the applications are endless. At the present time much research is taking place to develop batteries for the electric car in order to reduce air pollution. Because of their wide application in everyday life we would be omitting a very significant topic if we didn't discuss batteries and cells to develop a general idea of their operations.

I. Definition of common battery terms

- A. Cell
- B. Electrodes
- C. Primary
- D. Voltaic
- E. Battery

II. Applications of batteries and cells

III. Characteristics of primary cells

- A. Voltage
- B. Current with relation to size
- C. Local action
- D. Discharge action
- E. Polarization

IV. Disadvantages of Primary Cells

A. Size for current capacity
B. Non-rechargeable
C. Shelf-life

V. Closure

DEMONSTRATION:

1. Present a cut-away showing an actual cell and point out the major parts.

2. A simple but impractical cell can be made by putting a strip of zinc and a strip of copper in water that has a little hydrochloric acid dissolved in it. Salt water, lemon juice, or tomato juice will also work. Connect an ammeter between the two strips, and slight amount of current will show.

3. Batteries must be tested under load if a voltage test is to be reliable. Use a small radio with batteries almost run down. Measure the voltage across the batteries with the switch turned off, then turn the radio switch on and show how the battery voltage drops drastically and the radio plays weak, distorted or not at all.

   Next install new batteries in the radio and measure before and after radio is turned on showing that the new batteries measure almost the same either without a load or with one.

   Measuring battery voltage without a load is NOT a reliable test.

LABORATORY OR OTHER ACTIVITIES:

1. A Penny-nickel battery using blotters soaked with salt water, or inserted into a lemon.

2. The student should perform jobs 40 and 41 in Understanding Electricity and Electronics, p. 217.

TEST ITEMS: (Oral, Written or Performance)

1. Diagram the construction of a zinc-carbon cell.

2. The primary cell is rechargeable. (T or F)

3. List the parts of a primary cell.

a. _____
b. _____
c. _____
d. _____

4. The dry cell battery is a

a. Recording cell
b. Polarized cell
c. Primary cell
d. Voltaic cell

Reference pp. 213-218 Lesson No. 21

SECONDARY CELLS

LESSON OBJECTIVE:

The student will be able to:

1. Define common battery terms for a secondary cell
2. Explain the characteristics of a secondary cell
3. List the disadvantages of secondary cells

SUPPLEMENTARY TEACHING ITEMS:

1. Transparencies No. EE19, EE20, EE21
2. Lead-acid storage battery
3. Hydrometer

PRESENTATION:

The secondary cell differs from the primary cell essentially in that the secondary cell can be recharged. In the discharge process of the primary cell some of the materials are consumed making it virtually impossible to recharge or reverse this chemical process. In the discharge of a secondary cell the materials of the cell are merely transferred from one electrode to the other. Recharging can be accomplished by sending an electric current through the battery in the opposite direction. In this lesson we want to discuss the characteristics and properties of secondary cells.

I. Definition of battery terms for secondary cells

- A. Cell
- B. Plate
- C. Electrolyte
- D. Specific gravity
- E. Hydrometer

II. Application of secondary cells

III. Characteristics of secondary cells

- A. Voltage
- B. Current with relation to size
- C. Discharge action
- D. Charge action

E. Ampere hour rating
F. Charging rate

IV. Disadvantage of secondary cells

A. Size for current capacity
B. Weight
C. Electrolyte (liquid)

V. Closure

DEMONSTRATION:

Using a hydrometer, show and explain how an automobile battery is checked.

LABORATORY OR OTHER ACTIVITIES:

1. The student should perform job 42 in Understanding Electricity and Electronics. p. 218.

2. The students should check secondary cells in a battery with a hydrometer.

TEST ITEMS: (Oral, Written or Performance)

1. The electrolyte of a lead-acid wet cell is

   a. Sal ammoniac
   b. Manganese dioxide
   c. Sulfuric acid
   d. Distilled water

2. Lead-acid cells are secondary cells. (T or F)

3. Lead-acid battery plates are held together by a

   a. Glass wool material
   b. Wood separators
   c. Grid work
   d. Hard rubber tube

4. What rules of safety should be followed when near lead-acid batteries?

Reference pp. 231, 235 Lesson No. 22

THERMOCOUPLES

LESSON OBJECTIVE:

The student will be able to:

1. Describe the materials used in a thermocouple.
2. Explain the theory of operation of the thermocouple.
3. List and describe briefly the applications of thermocouple.

SUPPLEMENTARY TEACHING ITEMS:

1. Heat source (candle or gas burner)
2. Thermocouples
3. Galvonometer
4. Transparency No. EE22

PRESENTATION:

Heat is another source for the production of electricity. When two dissimilar metals are physically connected together and heated at their junction, an electrical potential is developed across that junction. If the temperature of the junction is increased the potential difference increases. This device is known as thermocouple.

I. Electricity developed by the application of heat

A. Thermocouple

1. Materials used
2. Theory of operation
   a. Hot junction
   b. Cold junction
3. Applications
   a. Pyrometers
   b. Gas thermal shut-off safety valve
   c. Space communication satelite (SNAP)
   d. Temperature gauges in automobiles
   e. Meters (electrical)

DEMONSTRATION:

Construct a circuit necessary to show a voltage. Point out the following:

1. Junctions
   a. Hot
   b. Cold

2. Heat applied develops a voltage

3. An increase in heat causes an increase in voltage

4. Not a large power source

LABORATORY OR OTHER ACTIVITIES:

The student should perform:

Job 47, p. 235 in Understanding Electricity and Electronics.

TEST ITEMS: (Oral, Written or Performance)

1. Two dissimilar metals are needed to construct a thermocouple. (T or F)

2. List four applications of a thermocouple.

3. A thermocouple is an excellent source for nearly unlimited voltages. (T or F)

Reference pp. 228-230, 233-234 Lesson No. 23

SOLAR BATTERIES

LESSON OBJECTIVE:

The student will be able to:

1. List the basic parts of the phototube and solar cell.
2. Explain the theory of operation of the phototube and solar cell.
3. List and briefly describe the applications of the phototube and solar cell.

SUPPLEMENTARY TEACHING ITEMS:

1. Transparency No. EE23
2. Phototube
3. Solar cells
4. VOM or VTVM
5. Connection leads
6. Light source

PRESENTATION:

There are many applications of photo electric devices which have become commonplace in the lives of all of us. In many places lights are turned on, doors opened, objects are counted, sorted and otherwise identified through the use of photo-electric devices.

In our discussions of these devices we want to discuss how a photo-electric tube and a solar cell operate and some of the applications in which they are used.

I. Photoelectricity

A. Phototube

1. Basic parts
2. Theory of operation
3. Application
   a. Film projectors
   b. Burglar alarms
   c. Door openers
   d. Counting machines

B. Solar cell (photovoltaic cells, photo cells)

1. Material
2. Theory of operation
3. Application
   a. Cells and batteries to power small earth-satellite radio transmitter
   b. Light meters
   c. Other control equipment

II. Closure

DEMONSTRATION:

1. Demonstrate a phototube and solar cell by setting up a single circuit with each.

2. Demonstrate the application by illustrating the sound track on a film and show the variation of light intensity passing through the film in the projectors. Also show light meters, automatic auto head light dimmers, "electric eye" on cameras, and light control switches.

LABORATORY OR OTHER ACTIVITIES:

The student should perform:

1. Job 45, p. 233 in Understanding Electricity and Electronics.

2. Job 46, p. 233-234 in Understanding Electricity and Electronics.

TEST ITEMS: (Oral, Written or Performance)

1. List several applications of phototubes and solar cells.

2. Explain the theory of operation of the solar cell.

3. What is the basic material used in a solar cell?

Reference pp. 231, 235 Lesson No. 24

PIEZOELECTRICITY

LESSON OBJECTIVE:

The student must be able to:

1. Describe the materials that will produce the piezoelectric effect.
2. Explain the theory of operation of a crystal.
3. List and describe the applications of crystals.

SUPPLEMENTARY TEACHING ITEMS:

1. Crystal phono pick-up
2. VTVM or oscilloscope
3. Crystal microphone

PRESENTATION:

Crystalline substances such as Rochell salt, quartz, tourmaline, and even cane sugar, will change their physical shape when a voltage is impressed upon the crystal. This action is also reversible, if a crystal is subjected to a mechanical strain a voltage will be provided across the crystal. This effect is called the Piezoelectric Effect.

Phono crystals and crystals used in radio and TV station transmitters are practical applications of the piezoelectric effect.

I. Piezoelectric effect

- A. Crystal
- B. Materials
- C. Theory of operation
- D. Applications
  - a. phono pick-up
  - b. crystal oscillators

II. Closure

DEMONSTRATION:

Demonstrate a crystal oscillator. View the waveform on scope.

Connect a phono pick-up cartridge to the lowest AC scale on the VTVM or an oscilloscope.

A very small voltage will be produced when a mechanical force is applied to the needle.

Explain to the students that this weak voltage must be fed through an amplifier to be audible.

LABORATORY OR OTHER ACTIVITIES:

The student should perform:

Job 48, p. 235, Understanding Electricity and Electronics.

TEST ITEMS: (Oral, Written or Performance)

1. The most common applications of the piezoelectric effect are _____ and _____.

2. List three crystaline materials that will produce the piezoelectric effect.

Reference pp. 138-143 Lesson No. 25

CAPACITORS

LESSON OBJECTIVE:

The student must be able to:

1. Describe the common types of capacitors.
2. Explain basic capacitor action (charging and discharging).
3. Explain capacitors in parallel and series.
4. Show how the voltage rating of capacitors vary when connected series or parallel.

SUPPLEMENTARY TEACHING ITEMS:

Various capacitors

PRESENTATION:

A capacitor in its simplest form consists of two metal plates separated by a thin layer of insulating material (dielectric). When connected to a voltage source (battery) the voltage forces electrons onto one plate, making it negative, and pulls them off the other, making it positive. Electrons cannot flow through the insulating material (dielectric). Since it takes a definite quantity of electrons to "fill up," or charge a capacitor, it is said to have a capacity.

Capacitors are the only device known to "store" electricity, so it will be interesting to study the various applications of capacitors.

I. Capacitors

- A. What is a capacitor
- B. Purpose
- C. Types and construction
- D. Charging and discharging
- E. Unit of measure of capacitors

II. Capacitors connections

- A. Parallel
- B. Series

C. Voltage ratings
   1. Increasing
   2. Decreasing
D. Variable capacitor
   1. Trimmer or padder
   2. Tuning

III. Uses of capacitors

A. Blocking
B. Coupling
C. Filtering
D. Tuning

IV. Closure

DEMONSTRATION:

1. Show the various kinds of capacitors which you have available.

2. Show the parts of an old paper capacitor by unrolling it.

   A. Leads
   B. Plates
   C. Dielectric

LABORATORY OR OTHER ACTIVITIES:

The student should perform:

Job 12, p. 142, in Understanding Electricity and Electronics.

TEST ITEMS: (Oral, Written or Performance)

1. The unit of capacitance is the

   A. Ohm
   B. Farad
   C. Henry
   D. Coulomb

2. List four common types of capacitors that are available.

3. Capacitors may be connected in series or in parallel to gain needed characteristics for a particular circuit. (T or F)

4. What is the purpose of a capacitor?

Reference pp. 181-184 Lesson No. 26

TRANSFORMERS

LESSON OBJECTIVE:

The student will be able to:

1. Explain mutual induction
2. Briefly describe the construction of the transformer
3. Explain briefly the operation of a step-up and step-down transformer.

SUPPLEMENTARY TEACHING ITEMS:

Transformer

PRESENTATION:

A transformer is a device with no moving parts but transfers energy from one circuit to another by electromagnetic induction. We have discussed the concept of self-induction and have seen its effects. However, with the transformer we must again see the effect of self-induction, as well as a new concept, that of mutual induction. In our discussion, only the the basic principles of transformer operations will be covered.

I. Mutual induction

Coupling

II. Transformer construction

A. Types of windings

1. Primary
2. Secondary

B. Types of cores

1. Shell
2. Closed core

C. Laminated cores

III. Step-up and step-down transformers

A. Voltage input versus voltage output

Turns-voltage ratio

B. Input voltage to transformers

1. AC
2. Pulsating DC

IV. Efficiency

V. Closure

DEMONSTRATION:

Here is a good place to tie this circuit in with the ignition coil circuit of a car. The switch is the "points" and the capacitor is the "condenser" in the auto ignition system. The transformer is the ignition coil which sends high voltage pulses to the spark plugs even though the battery voltage is only 12 volts. High voltage pulses may go as high as 15 to 20 thousand volts from the average auto ignition coil though may not go over 7 to 10 thousand volts in many cars.

Another demonstration can be presented by using a special toroid transformer designed for just this purpose. You can wind on a few turns of wire through the "doughnut" coil and plug the transformer into the AC power line. Connect a low voltage lamp across the few turns of wire and even though there is no physical connection, the lamp lights by induction. This demonstration can also show that increasing the turns increases the voltage.

LABORATORY OR OTHER ACTIVITIES:

The student should perform:

Job 28, Properties of the Transformer, pp. 186-187 in Understanding Electricity and Electronics.

TEST ITEMS: (Oral. Written or Performance)

1. In a step-up transformer the primary has more turns than the secondary. (T & F)

2. With no load on the secondary, the current in the primary is:

a. zero
b. limited only by the resistance of the winding
c. determined by the C.E.M.F. of the secondary.
d. determined by the C.E.M.F. of the primary

3. What are the two types of cores used with transformers?

4. Why are the cores of transformers laminated?

Reference pp. 219-223, 226-227 Lesson No. 27

DIRECT-CURRENT GENERATORS

LESSON OBJECTIVE:

The student must be able to:

1. Explain the operation of a basic direct-current.
2. List and describe the parts of a direct-current generator.
3. Draw and explain a pulsating voltage waveform.

SUPPLEMENTARY TEACHING ITEMS:

Simple direct-current generator

PRESENTATION:

In the study of magnetism, we learned that a current-carrying conductor produces a magnetic field about itself. It is also true that a changing magnetic field may produce an electromagnetic field in a conductor. If a conductor lies in a magnetic field, and either the field or conductor moves, an electromagnetic field is generated in the conductor. This effect or producing electricity with a moving conductor in a magnetic field is the concept we will discuss and apply to direct-current generation.

I. Basic direct-current generator

- A. Single loop generator
- B. Multi-coil generator
- C. Indirect voltage in loop
- D. Commutator action

II. General construction of a direct-current generator

- A. Field windings
- B. Armature
- C. Commutation
- D. Brushes
- E. Pole pieces

III. Closure

Today we discussed construction of the direct-current generator, how it functions and the principles involved.

DEMONSTRATION:

1. Disassemble an old automobile generator and point out the main parts.

2. Show on an oscilloscope a pulsating direct-current waveform. (An unfiltered power supply can be used.)

LABORATORY OR OTHER ACTIVITIES:

The student should perform Job 43, pp. 226,227, in Understanding Electricity and Electronics.

TEST ITEMS: (Oral, Written or Performance)

1. A direct-current generator is a rotating machine that converts

   a. Electrical energy to mechanical energy
   b. Mechanical energy to electrical energy
   c. Low mechanical energy to a higher level mechanical energy.
   d. Low electrical energy to a higher level electrical energy.

2. Commutator segments are insulated from each other by

   a. Small strips of wood
   b. A rubber unit
   c. Laminated varnish
   d. Sheet mica

3. List the parts of a direct-current generator.

Reference pp. 219-221, 227-228 Lesson No. 28

PRINCIPLES OF AN AC GENERATOR

LESSON OBJECTIVE:

The student must be able to:

1. Explain the operation of a basic one loop alternating-current generator.
2. List and describe the parts of an alternating-current generator.
3. Draw and explain the sine wave representation of alternating-current.

SUPPLEMENTARY TEACHING ITEMS:

1. Transparencies No. EE24, EE25
2. Simple alternating-current generator and sine wave

PRESENTATION:

Most of the electric power used today is produced by alternating-current generators. AC generators (alternators) are made in many different sizes, depending on their intended use. For example, any one of the alternators at Boulder Dam produces millions of volt-amperes, while small generators for emergency use in the home produce only a few thousand volt-amperes.

Regardless of size, however, all generators operate on the same basic principle -- a magnetic field cutting through conductors, or conductors passing through a magnetic field.

I. Basic alternating-current generator

- A. Single loop generator
- B. Development of the sine wave
- C. Slip-ring
- D. Induced voltage in the loop

II. General construction of an alternating-current generator.

- A. Field windings
- B. Armature
- C. Startor
- D. Excitation voltage

III. Types of alternating-current generators

A. Revolving armature
B. Revolving field

IV. Closure

DEMONSTRATION:

1. Show an AC sine wave on the oscilloscope (just for viewing and familiarization not for discussing the sine wave).

2. An automobile alternator may be disassembled to show its parts.

LABORATORY OR OTHER ACTIVITIES:

The student should perform Job 44, page 228 in Understanding Electricity and Electronics.

TEST ITEMS: (Oral, Written or Performance)

1. An alternating-current armature is always the

   a. Rotating part of the generator
   b. Stationary part of the generator
   c. Conductor into which voltage is induced
   d. Conductor through which direct-current flows

2. The alternating current field is always the

   a. Rotating part of the generator
   b. Stationary part of the generator
   c. Conduction into which voltage is induced
   d. Conductor through which direct-current exciter current flows

3. The simple direct-current and alternating-current generators are alike except for the slip-rings and commutator. (T or F)

Reference pp. 178, 274-282 Lesson No. 29

BASIC MOTOR ACTION

LESSON OBJECTIVE:

The student will be able to:

1. Explain basic motor action
2. Describe commutation action of a simple electric motor.
3. List and describe the parts of an electric motor.

SUPPLEMENTARY TEACHING ITEMS:

Transparencies No. EE26, EE27

PRESENTATION:

The electric motor is one of the greatest labor saving devices man has ever made. Just for a minute, stop and think about the many ways electric motors are used. You might include in your list washers, dryers, starter motors on automobiles, furnace motor, electric appliances, and various other machines. The list could go on and on. Therefore, it is important to be knowledgeable of the applications and principles of electric motors and this is what we plan to discuss in this assignment.

I. Review concept of a magnetic field about a current carrying conductor.

   Direction of field with relation to current

II. Force acting on a conductor (motor action)

   Motion of the conductor with relation to direction or current

III. Commutation

   A. Segments of the commutator
   B. Commutator action

IV. Basic parts of an electric motor

   A. Field
   B. Armature

C. Brushes and holders
D. Commutator

V. Closure

DEMONSTRATION:

1. Have several motors on hand and name and explain the various parts.

2. Disassemble motor and name and show parts.

LABORATORY OR OTHER ACTIVITIES:

Have the student perform the following:

In Understanding Electricity and Electronics, perform job #24, p 178 (optional - perform job #52, p. 282).

TEST ITEMS: (Oral, Written or Performance)

1. Which of the following is not a part for an electric motor?

   a. starter
   b. rotor
   c. commutator
   d. armature
   e. pulley

2. Describe basic motor action.

3. What is a commutator? What purpose does it serve?

4. Explain 4 applications for electric motors.

Reference pp. 360-366 Lesson No. 30

PRODUCING AND TRANSMITTING ELECTRICITY

LESSON OBJECTIVE:

The student will be able to:

1. Explain how electricity is produced.
2. List the common methods of producing electricity for commercial use.
3. Describe how electricity is transmitted from the producer to the consumer.

SUPPLEMENTARY TEACHING ITEMS:

1. Transparencies No. EE28, EE29, EE30, EE31, EE32
2. Resource people from local power company
3. Fieldtrip

PRESENTATION:

Electricity is generated at power plants and must be transmitted to the consumer. There are three main ways in which electricity is generated.

Huge turbine-generators produce high voltage electricity which is stepped-up even higher in order to transmit it great distances to where it will be used. Because the voltage is so high it cannot be used in the home or factory without first being stepped-down.

I. Type of electrical generating plants

- A. Hydroelectric plants
- B. Steam-electric plants
- C. Atomic-electric plants

II. Power-plant generators

- A. Steam turbine
- B. Diesel-power plants

III. Electric-power transmission

- A. Circuit breakers
- B. Transformers
- C. Transmission towers
- D. Transmission lines

IV. Electric-energy distribution

A. Primary substation transformers
B. Substations
C. Distribution transformers

V. Transformers

A. Stepped-up transformers
B. Stepped-down transformers

VI. Electric-energy in the future

DEMONSTRATION:

No demonstration planned for this lesson.

LABORATORY OR OTHER ACTIVITIES:

1. Resource person - invite a representative from the local power company to discuss the work of his organization.

2. Field-trip - if community has a electrical generating plant or substation, make arrangements for a guided tour.

TEST ITEMS: (Oral, Written or Performance)

1. Name the three types of plants that produce electric energy.

2. Circuit breakers are used to:

A. Step-up the voltage
B. Step-down the voltage
C. Protect the electrical system
D. Transmit the electrical energy

Reference pp. 380-388 Lesson No. 31

CAREER OPPORTUNITIES IN ELECTRICITY-ELECTRONICS

LESSON OBJECTIVE:

The student will be aware of the career opportunities in the electricity-electronics field, training requirements, working conditions, and benefits of this kind of work.

SUPPLEMENTARY TEACHING ITEMS:

Occupational Outlook Handbook, U. S. Dept. of Labor
Available in your school library.

PRESENTATION:

Many job opportunities are available to persons with training in electricity-electronics. Although a single course in electricity does not prepare a person to enter work in this field, it does provide basic information which will be helpful during further training for many jobs in this area of work.

Electricity-electronics is one of the most rapidly expanding industries in the world. Employment opportunities for qualified persons are almost unlimited. These opportunities should increase as new uses are found for electrical and electronic appliances. In this lesson we shall examine some of the occupations which make up the electrical-electronic industries.

I. Electrical occupations

- A. General employment outlook
- B. Electrical or electronic engineering
- C. Construction electricians
- D. Maintenance electricians

II. Electronic occupations

- A. Radio and television repairman
- B. Broadcasting jobs
- C. Electronic-equipment manufacturing jobs
- D. Research jobs

III. Military occupations

IV. Electric light and power industry

V. The telephone industry

VI. Training requirements

DEMONSTRATION:

This would be an excellent time to invite resource persons from the Telephone Company, Power and Light Company, or local electronic firms to speak to the class concerning job opportunities, training requirements, working conditions, etc. in the electricity-electronic industries.

LABORATORY OR OTHER ACTIVITIES:

Ask your school librarian to conduct a guided tour of the library for your students. The location of materials concerning jobs, junior colleges and university catalogs should be pointed out to the students.

Students should be allowed time to browse through these materials.

TEST ITEMS: (Oral, Written or Performance)

1. Name some jobs in the electric light and power industry.
2. What kind of training does a radio and television repairman need?
3. What vocational-technical training is offered by the junior college in your district?

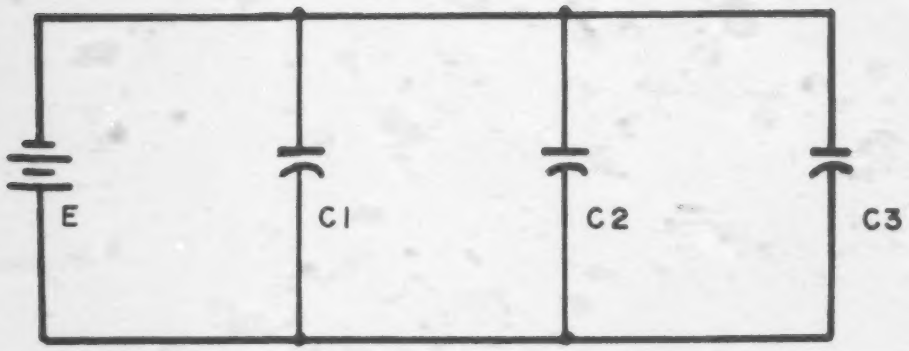
TRANSPARENCY MASTERS

84

OBJECTIVES

1. DEVELOP INSIGHTS AND BASIC UNDERSTANDINGS OF ELECTRICITY-ELECTRONICS AND ITS PLACE IN OUR CULTURE.
2. DISCOVER AND DEVELOP TALENTS, ATTITUDES, INTERESTS AND INDIVIDUAL POTENTIAL RELATED TO ELECTRICITY-ELECTRONICS.
3. DEVELOP ABILITIES IN THE PROPER USE OF TOOLS, MACHINES AND PROCESSES USED IN ELECTRICITY-ELECTRONICS.
4. DEVELOP AN UNDERSTANDING OF A VARIETY OF CAREERS, THEIR REQUIREMENTS, TRAINING AVAILABILITY AND FUTURE EMPLOYMENT OPPORTUNITIES IN ELECTRICITY-ELECTRONICS.
5. DEVELOP SAFETY CONSCIOUSNESS AND FAVORABLE ATTITUDES TOWARD ELECTRICITY-ELECTRONICS.

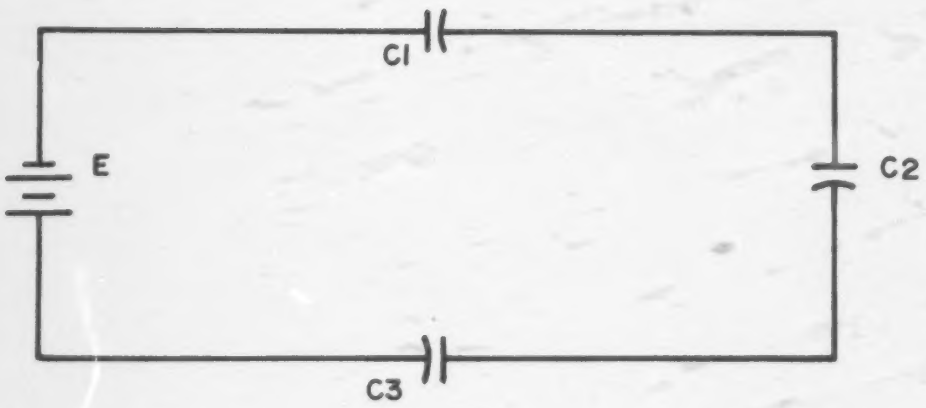
CAPACITORS IN PARALLEL AND IN SERIES



$C_t = C_1 + C_2 + C_3$

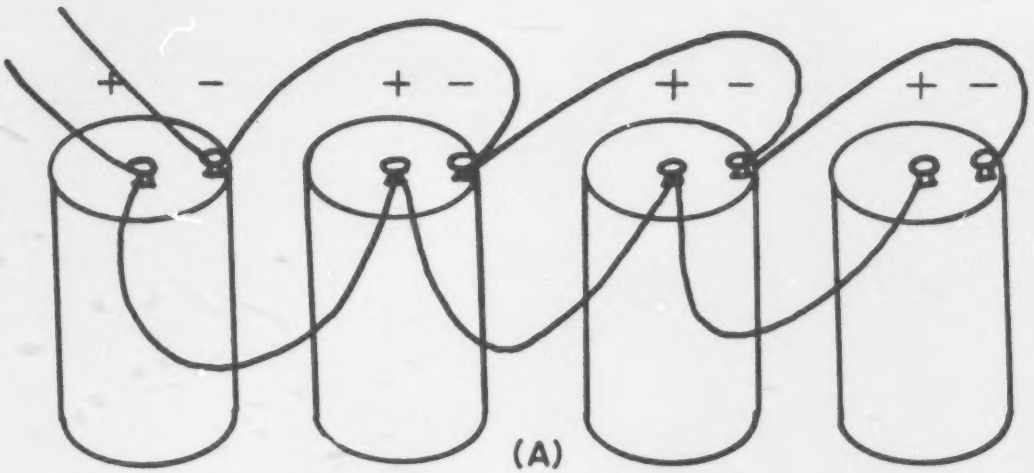
(A)
PARALLEL

(B)
SERIES

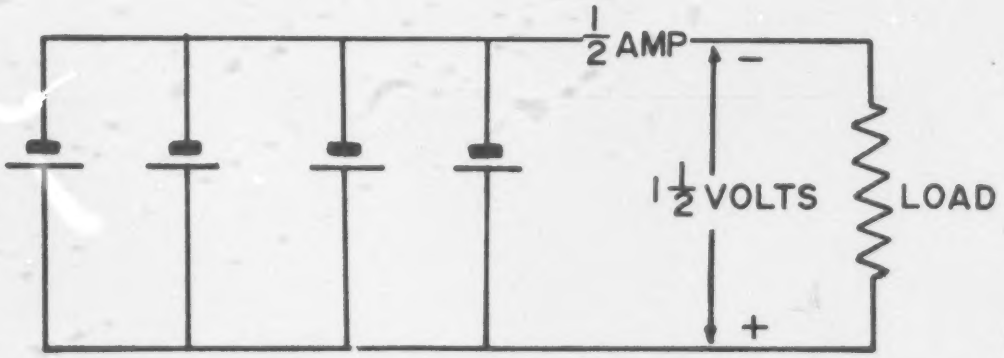


$$\frac{1}{C_t} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL



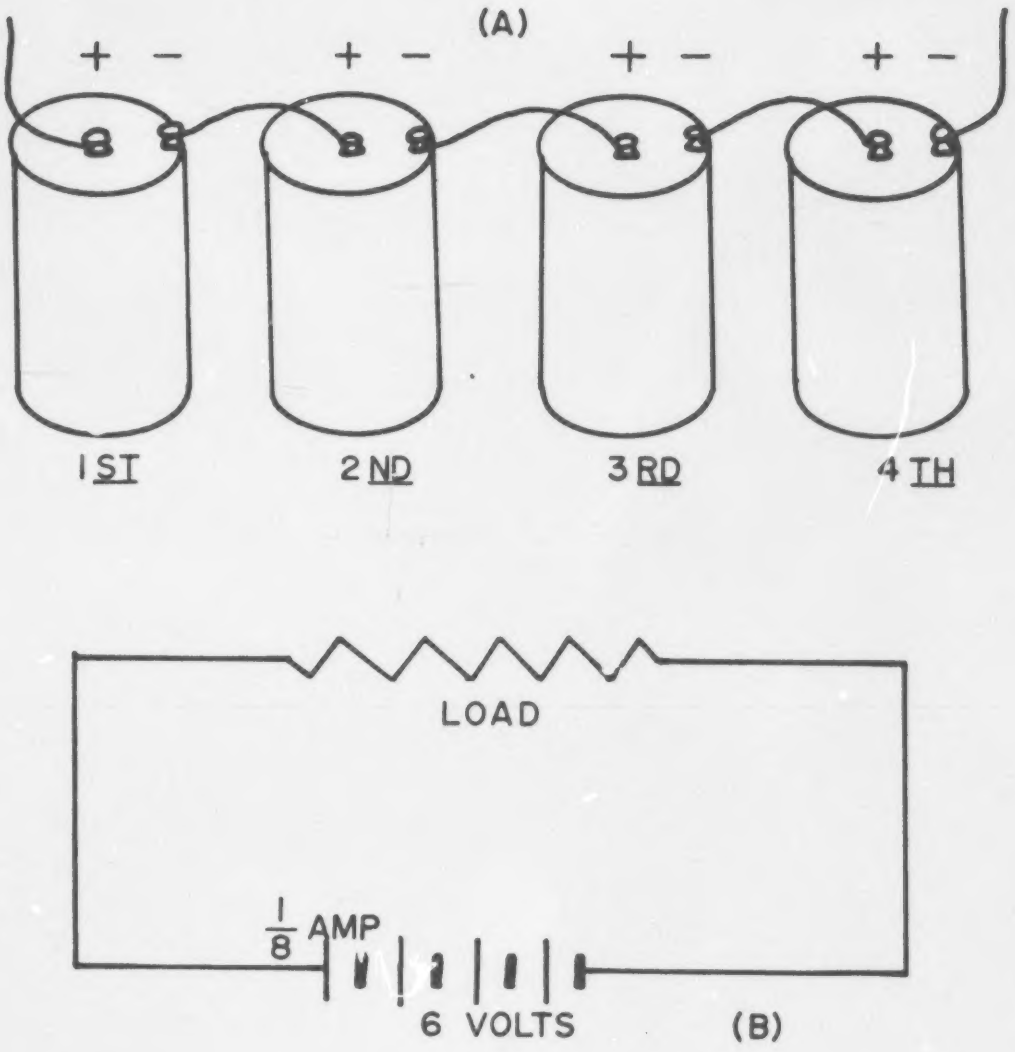
(A)



(B)

(A) PICTORIAL VIEW OF PARALLEL-CONNECTED CELLS:
(B) SCHEMATIC OF PARALLEL CONNECTIONS

IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL



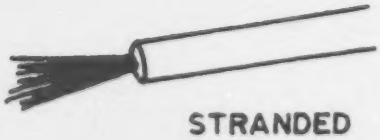
(A) PICTORIAL VIEW OF SERIES-CONNECTED CELLS;
(B) SCHEMATIC OF SERIES CONNECTION

DIFFERENT SIZE OF CONDUCTORS

SOLID

TWIST STRANDED WIRE

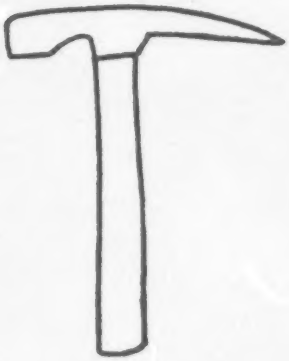
ANTENNA WIRE

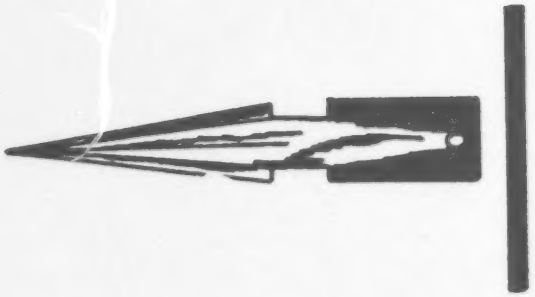


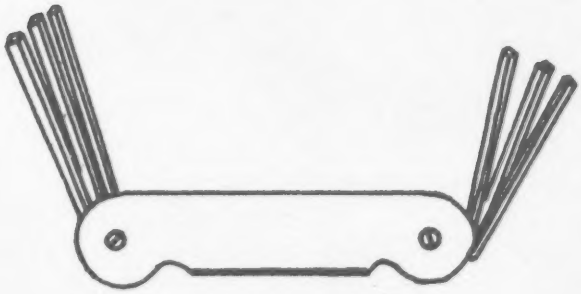
STRANDED

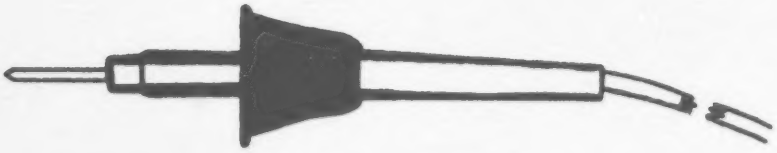
SINGLE STRAND

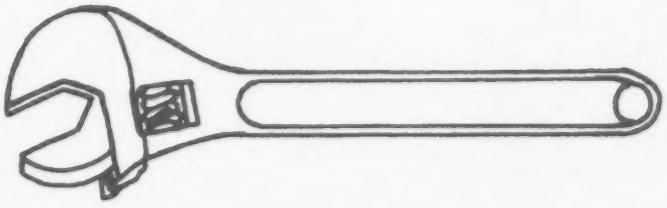
BASIC HAND TOOLS

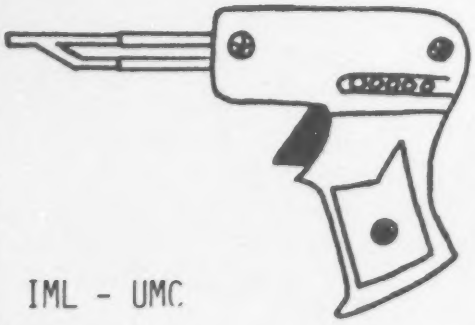


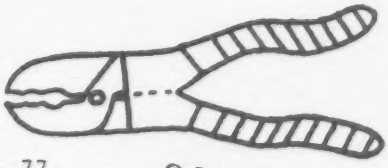




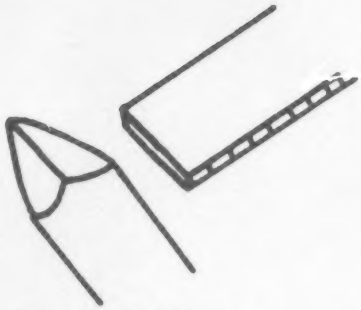






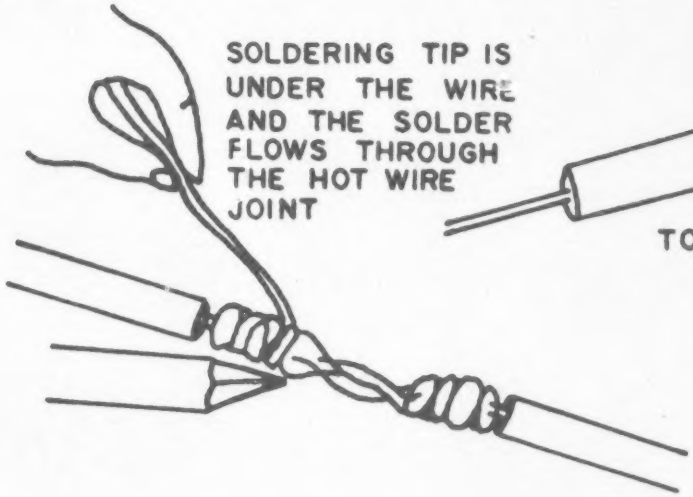


SOLDERING TECHNIQUE



FREE FROM
DIRT AND PITS

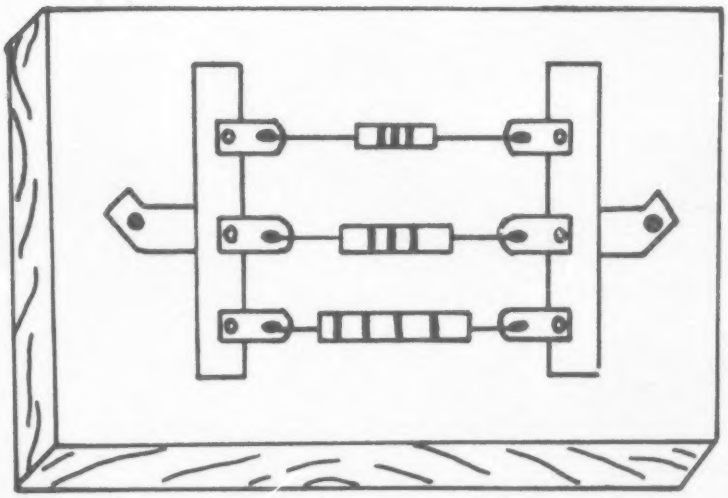
GOOD



SOLDERING TIP IS
UNDER THE WIRE
AND THE SOLDER
FLOWS THROUGH
THE HOT WIRE
JOINT

POOR
TOO MUCH SOLDER

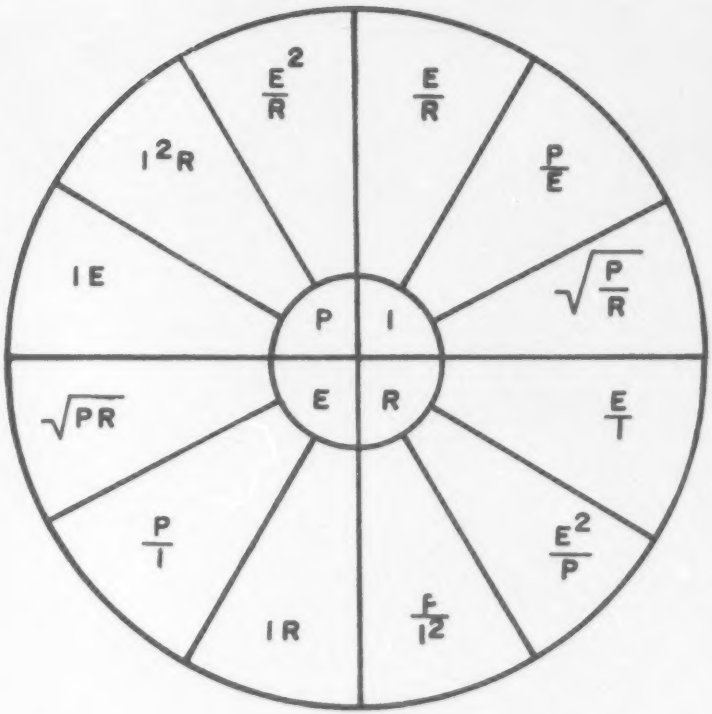
PARTS
IDENTIFICATION



IML - UMC

PROPER WAY OF MOUNTING PARTS

SUMMARY OF BASIC FORMULAS



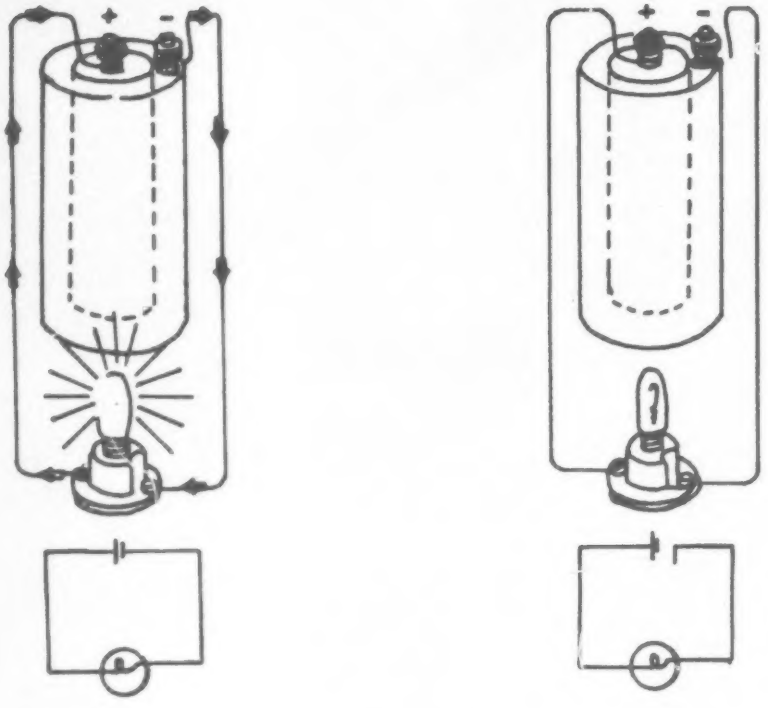
IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL

(A)

CLOSED CIRCUIT

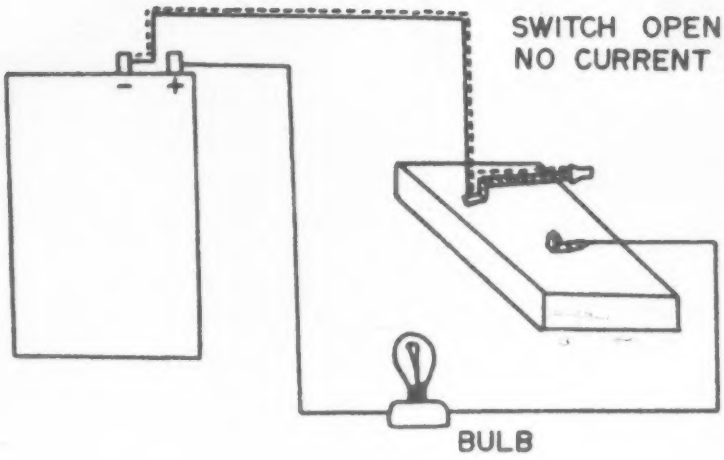
(B)

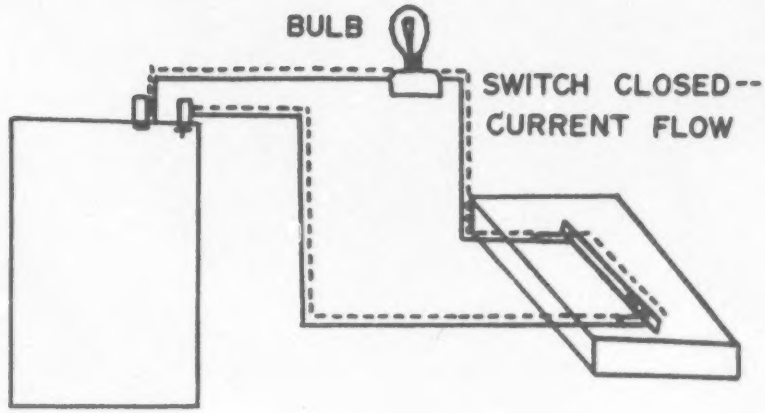
OPEN CIRCUIT



(A) SIMPLE ELECTRIC CIRCUIT (CLOSED); (B) SIMPLE ELECTRIC CIRCUIT (OPEN)

CIRCUIT PICTORIAL





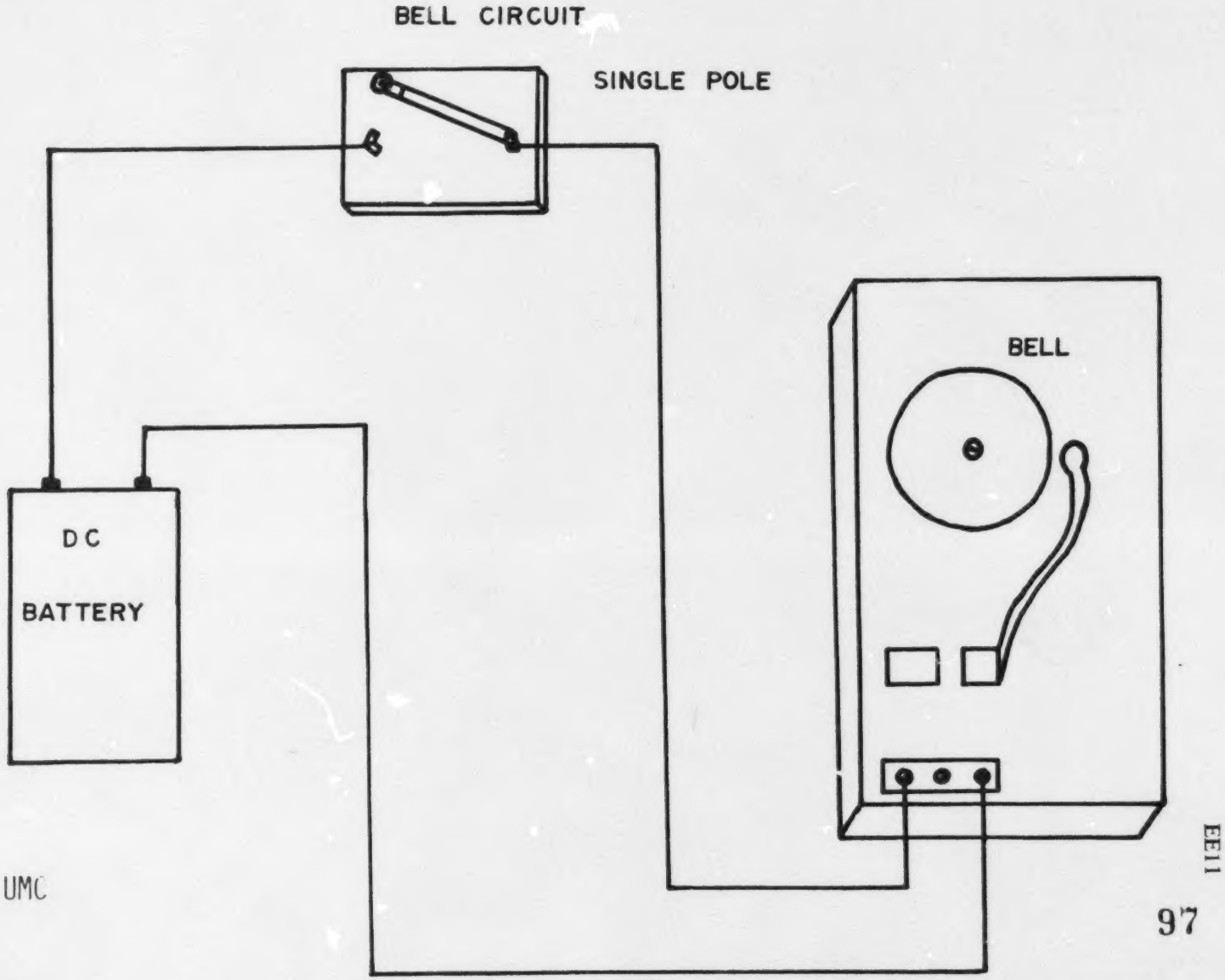
81

IML - UMC

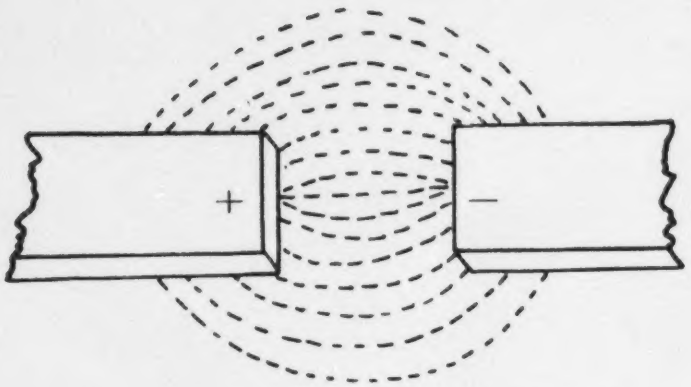
94

95

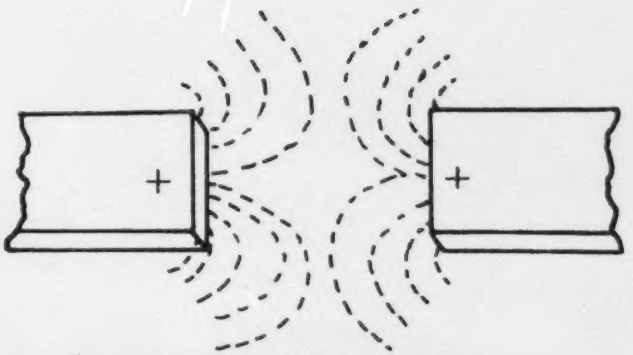
EE10


BELL CIRCUIT
SINGLE POLE
BELL
DC
BATTERY

MAGNETIC POLES

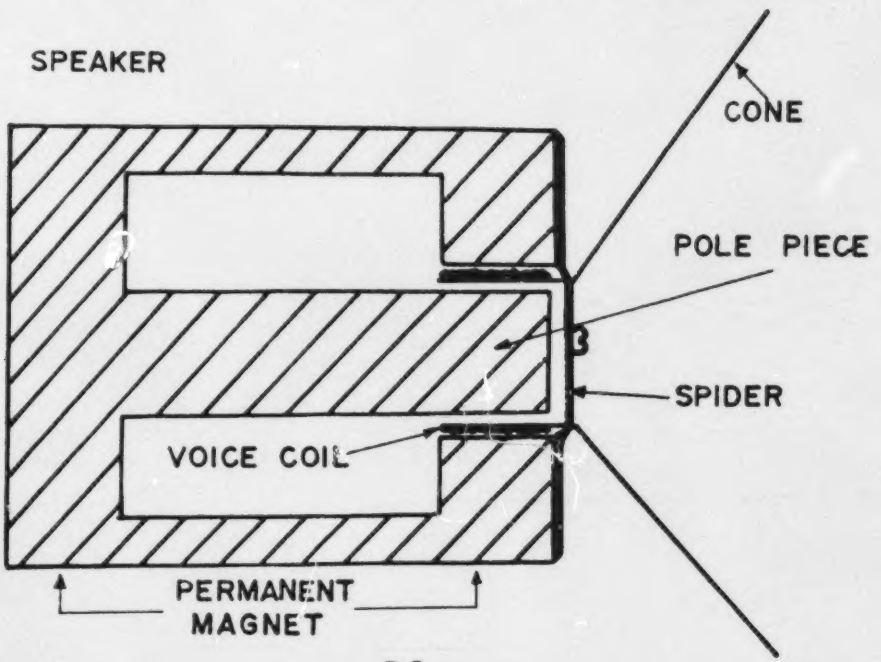


UNLIKE POLES ATTRACT

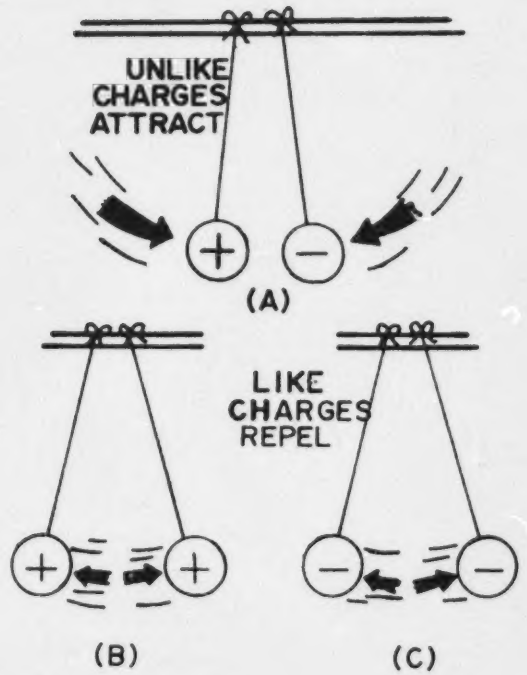


LIKE POLES REPEL

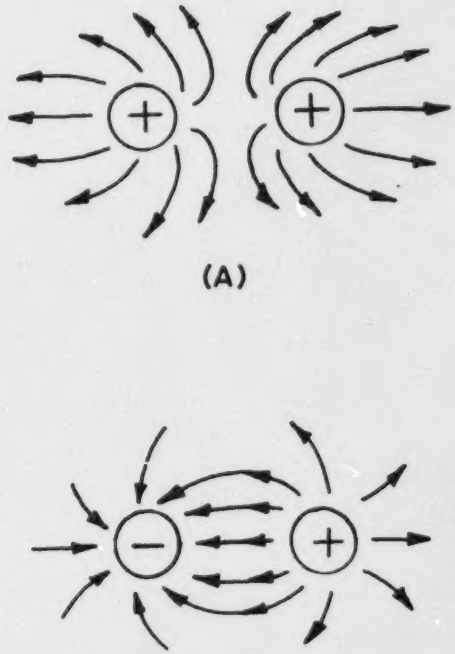
SPEAKER



IML - UMC



REACTION BETWEEN CHARGED BODIES

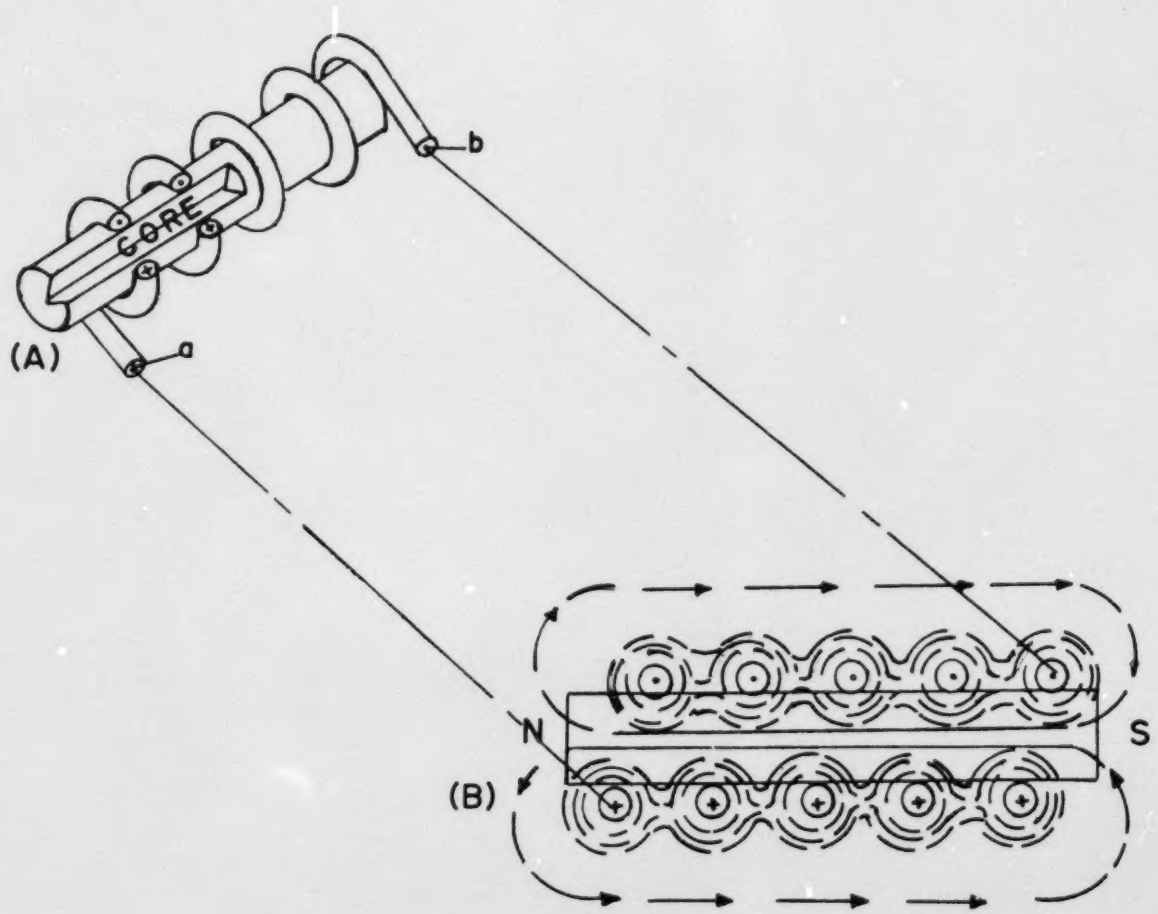


ELETROSTATIC LINES OF FORCE

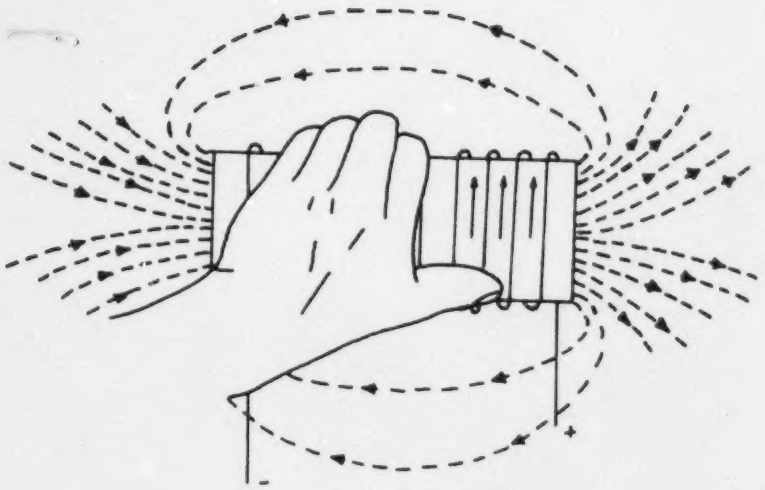
IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL

MAGNETIC FIELD

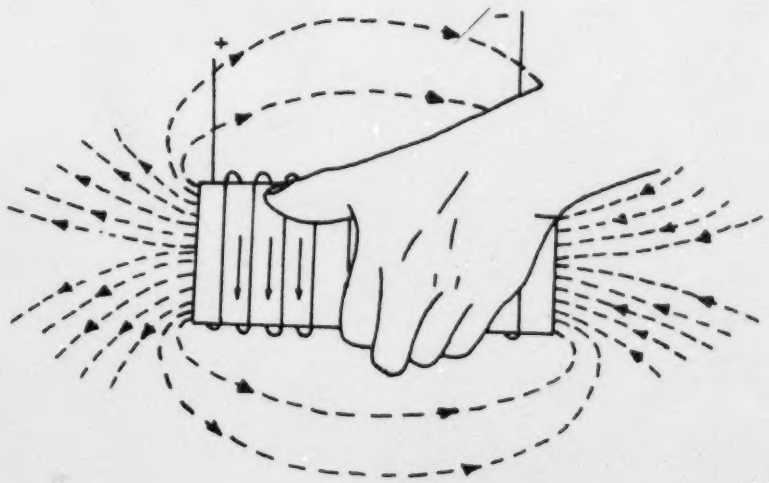
PRODUCED BY A CURRENT-CARRYING COIL



IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL



(A)

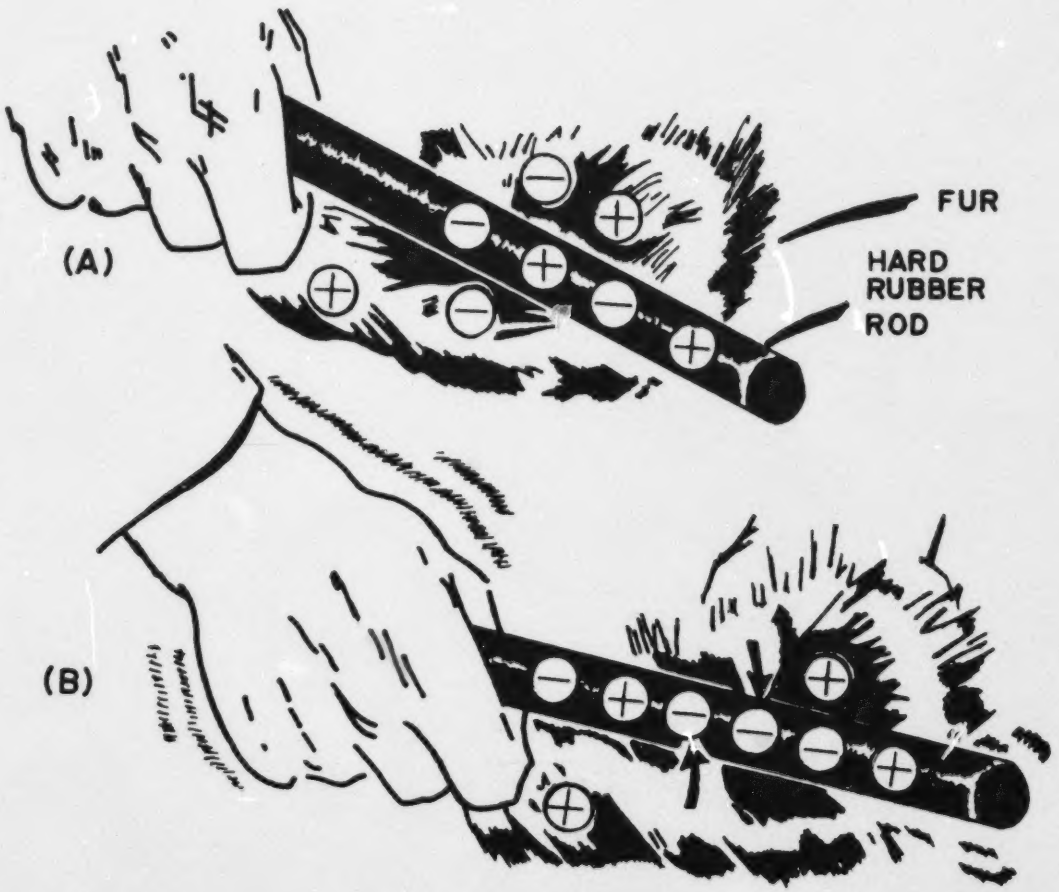


(B)

LEFT-HAND RULE FOR COIL POLARITY

IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL

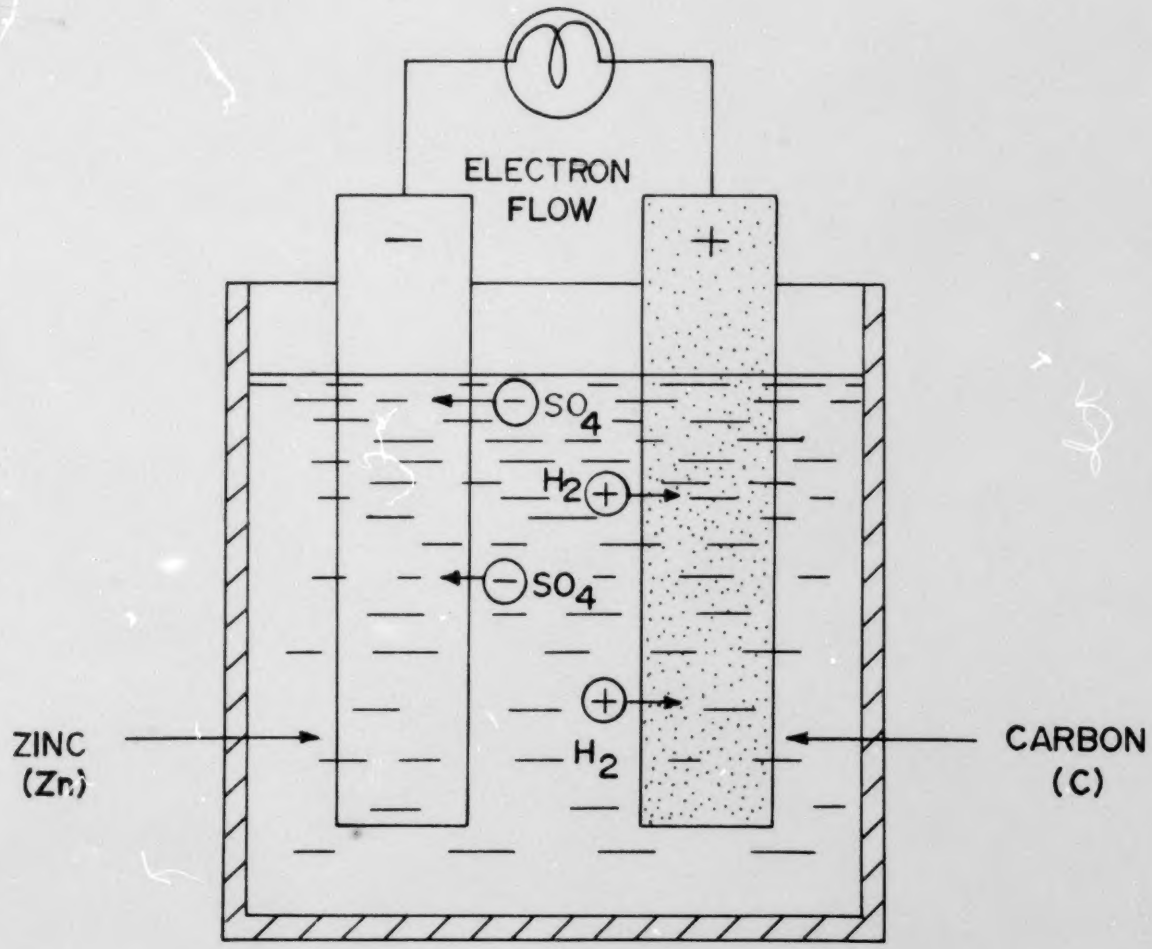
CHARGES AND ELECTRONS
ARE PRESENT IN EQUAL
QUANTITIES IN THE ROD AND FUR



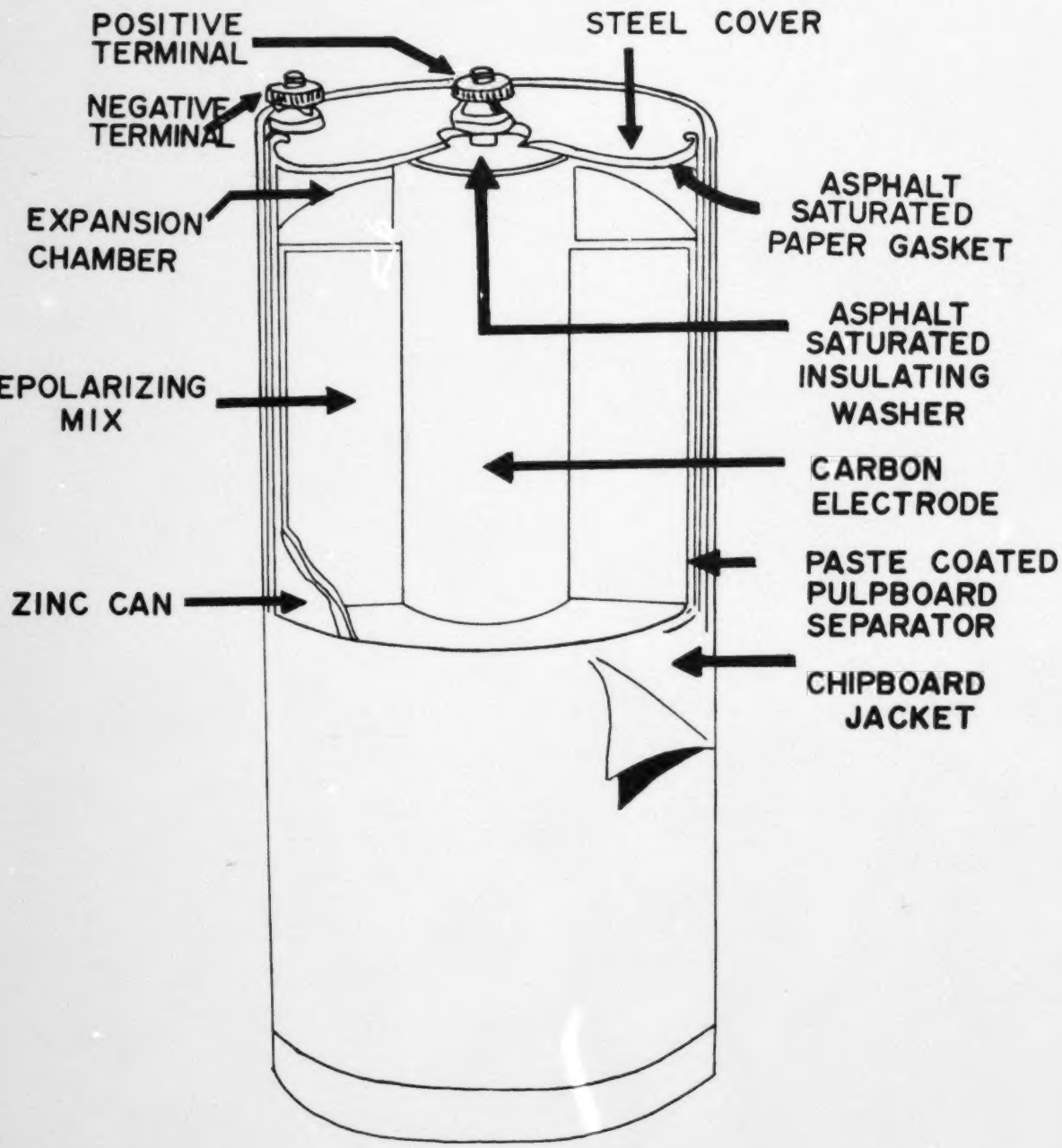
ELECTRONS ARE TRANS-
FERRED FROM THE FUR
TO THE ROD

PRODUCING STATIC ELECTRICITY BY FRICTION

IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL

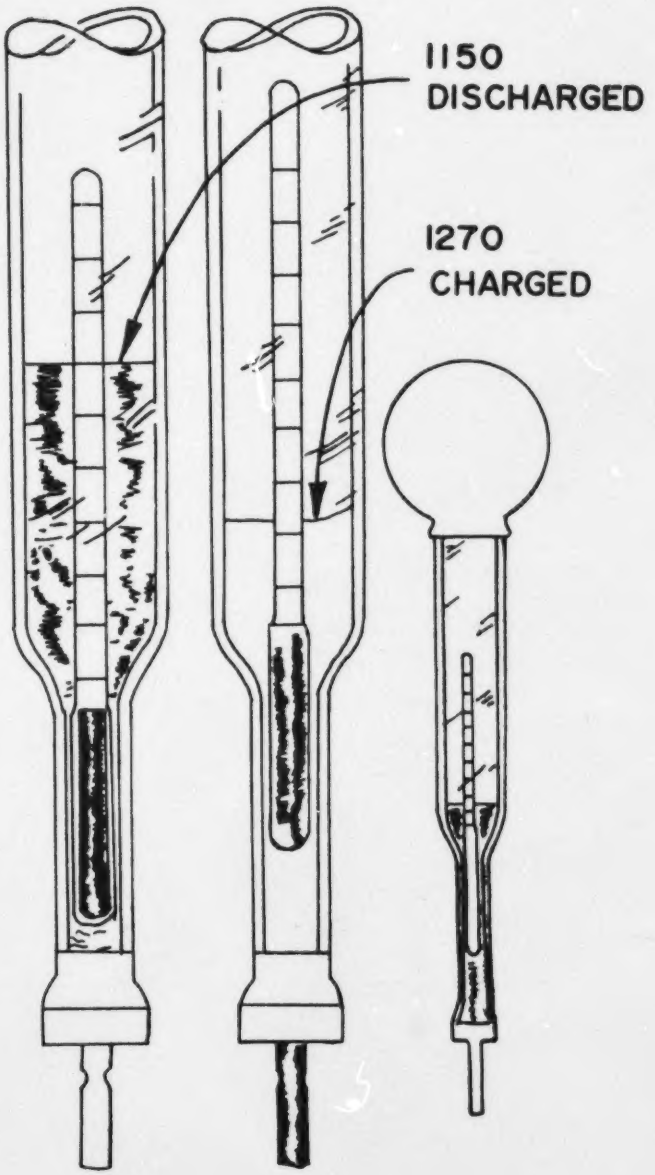


SIMPLE VOLTAIC CELL



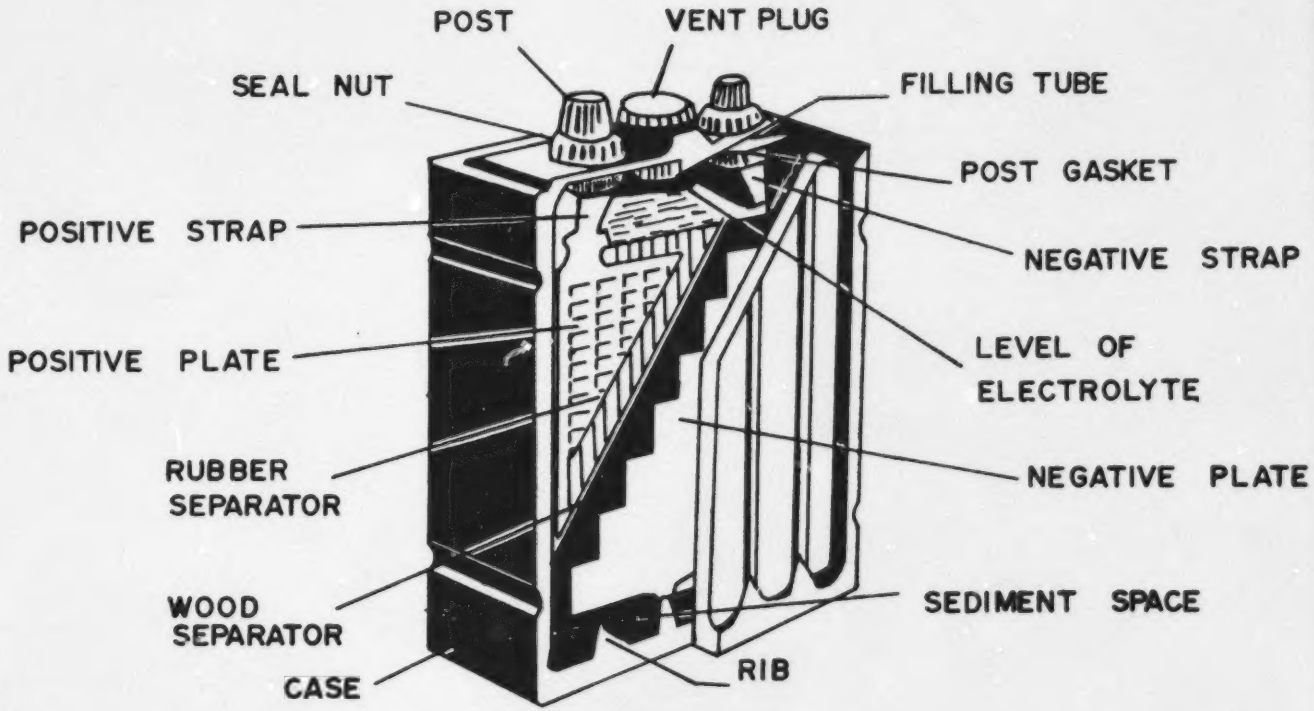
CUTAWAY VIEW OF THE GENERAL-PURPOSE DRY CELL

IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL



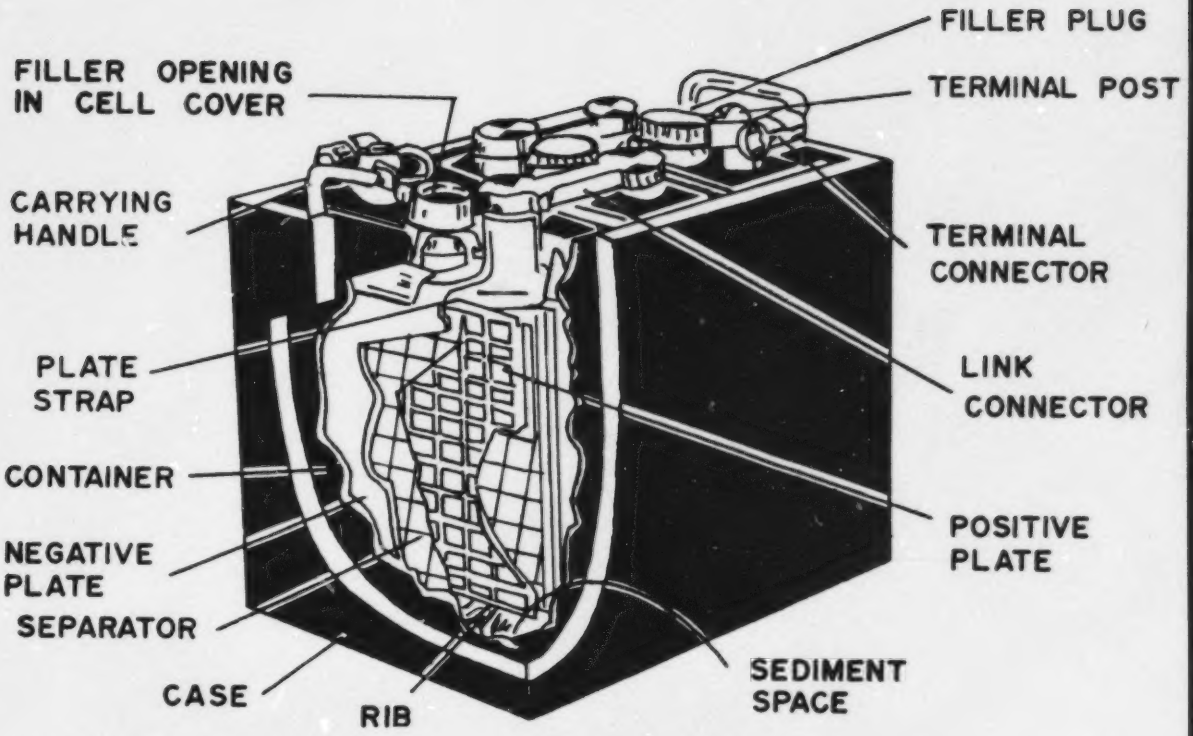
TYPE - B HYDROMETER

IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL



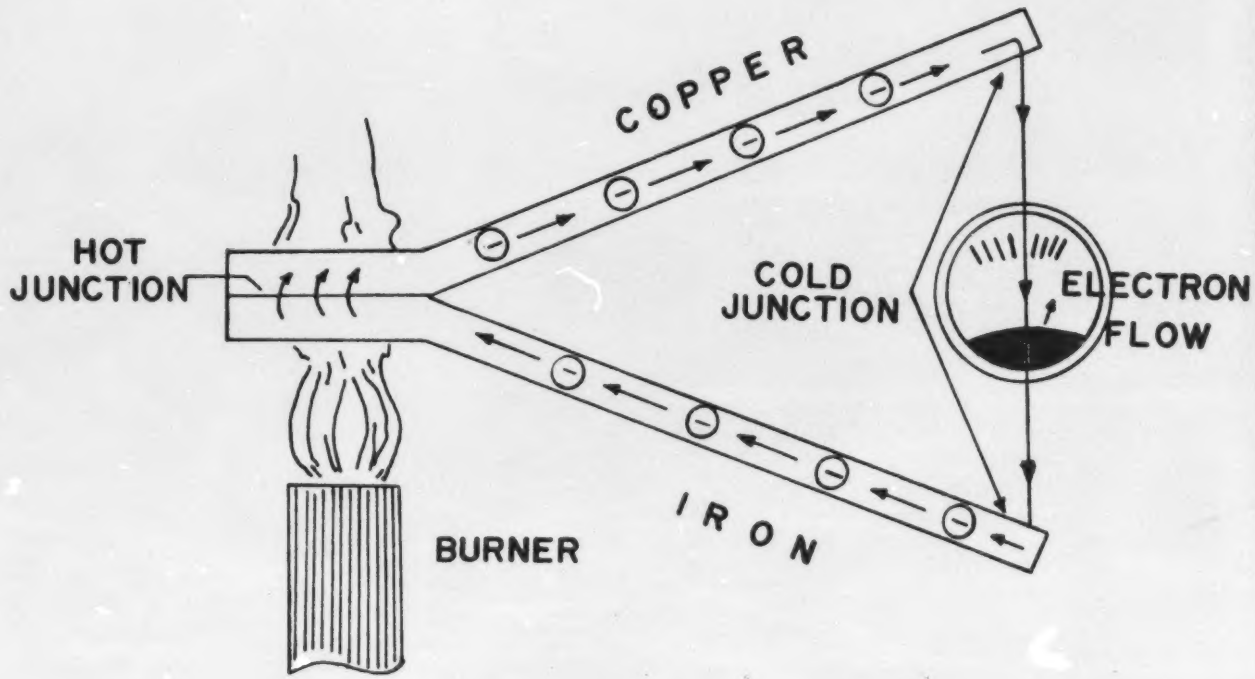
LEAD-ACID CELL

COURTESY BUREAU OF NAVAL PERSONNEL



LEAD-ACID BATTERY

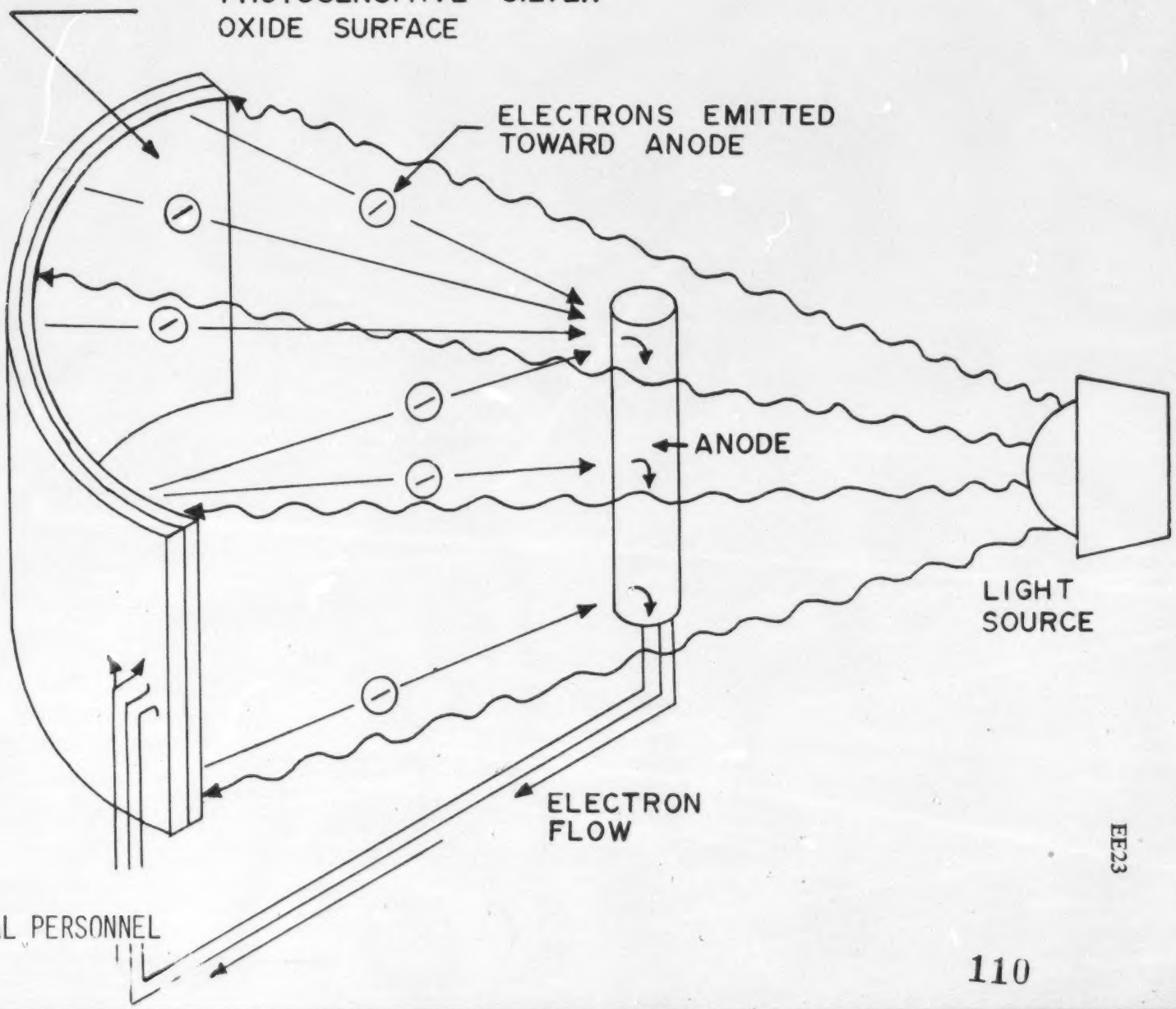
IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL



VOLTAGE PRODUCED BY HEAT

IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL

SOLAR CELL



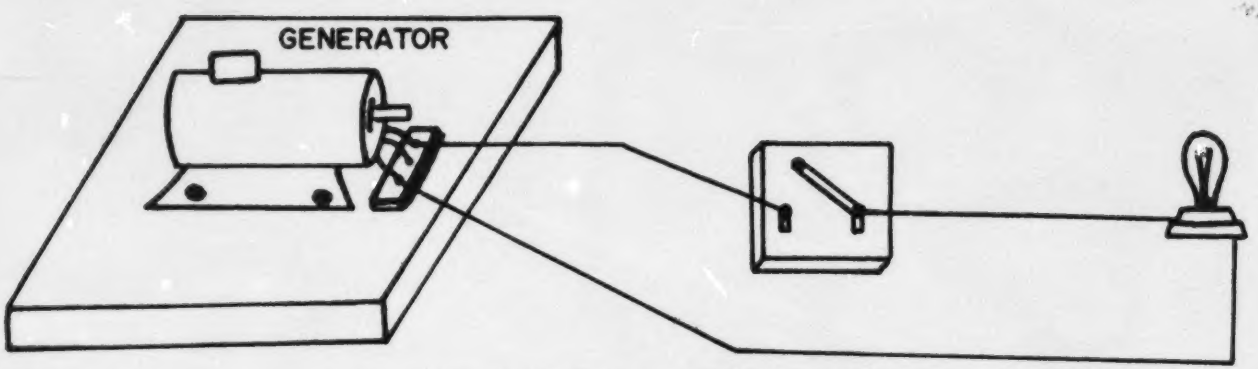
94

EE23

ML - UMC

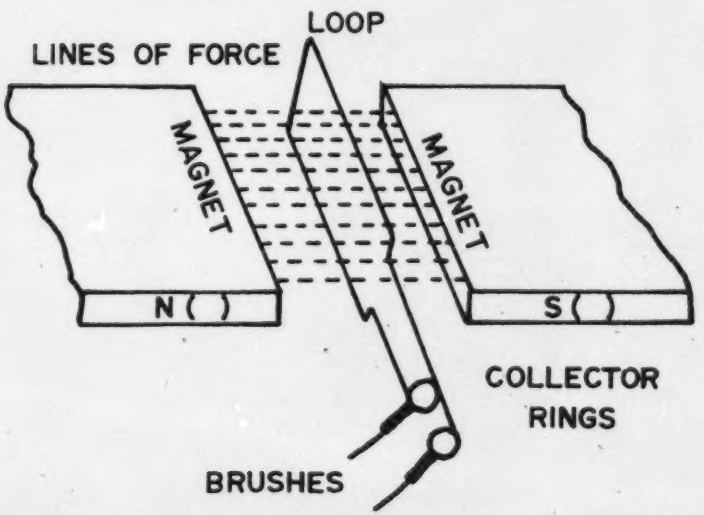
OURTESY BUREAU OF NAVAL PERSONNEL

GENERATION OF ELECTRICITY

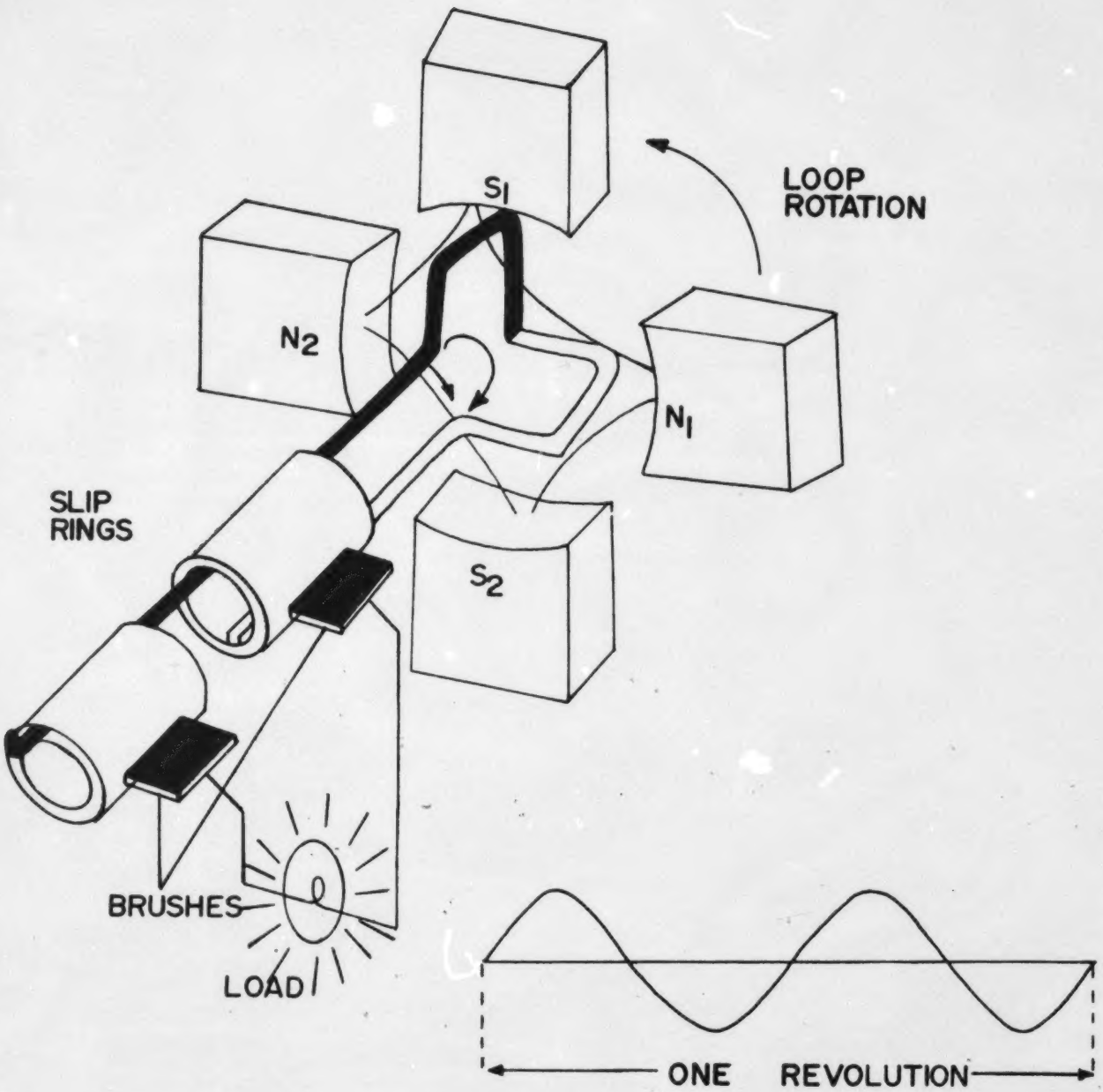


GENERATOR -- A SOURCE OF ELECTRICITY

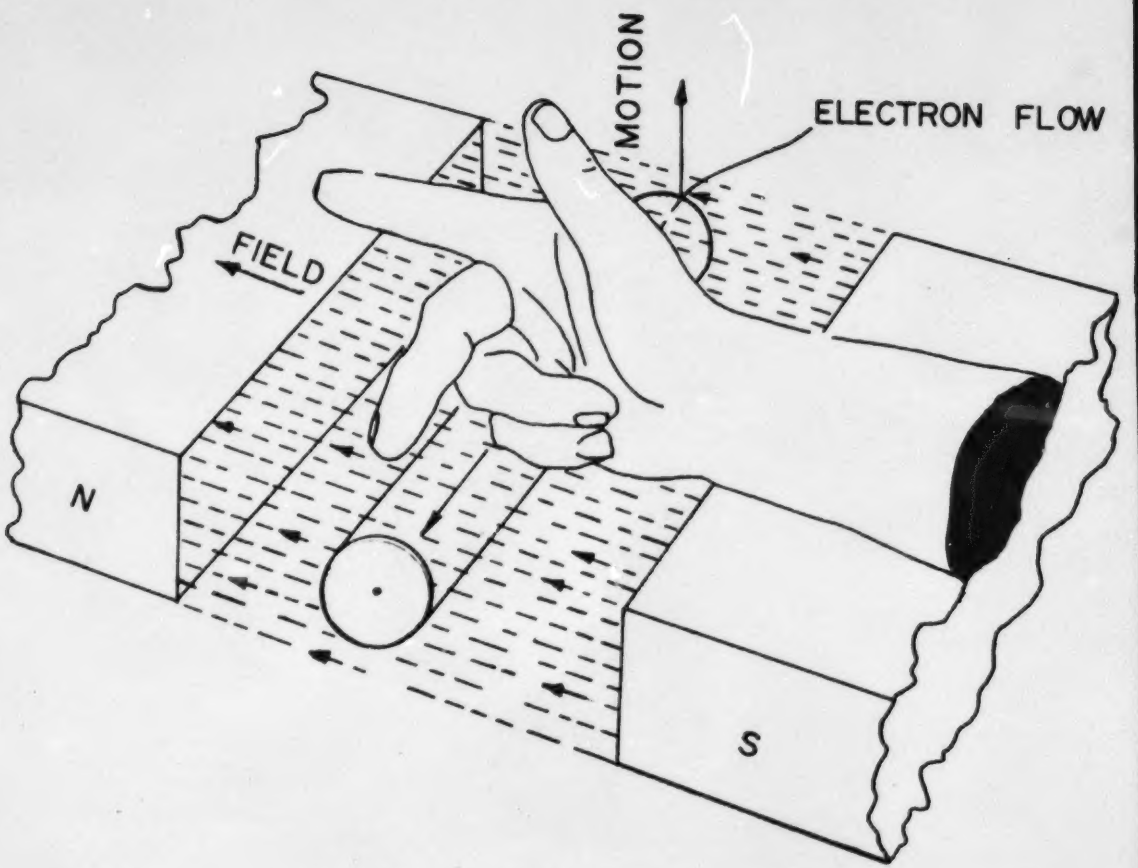
95



A SIMPLE ALTERNATING CURRENT GENERATOR WITH A SINGLE LOOP OF WIRE ROTATING IN THE MAGNETIC FIELD BETWEEN TWO POLES OF A MAGNET



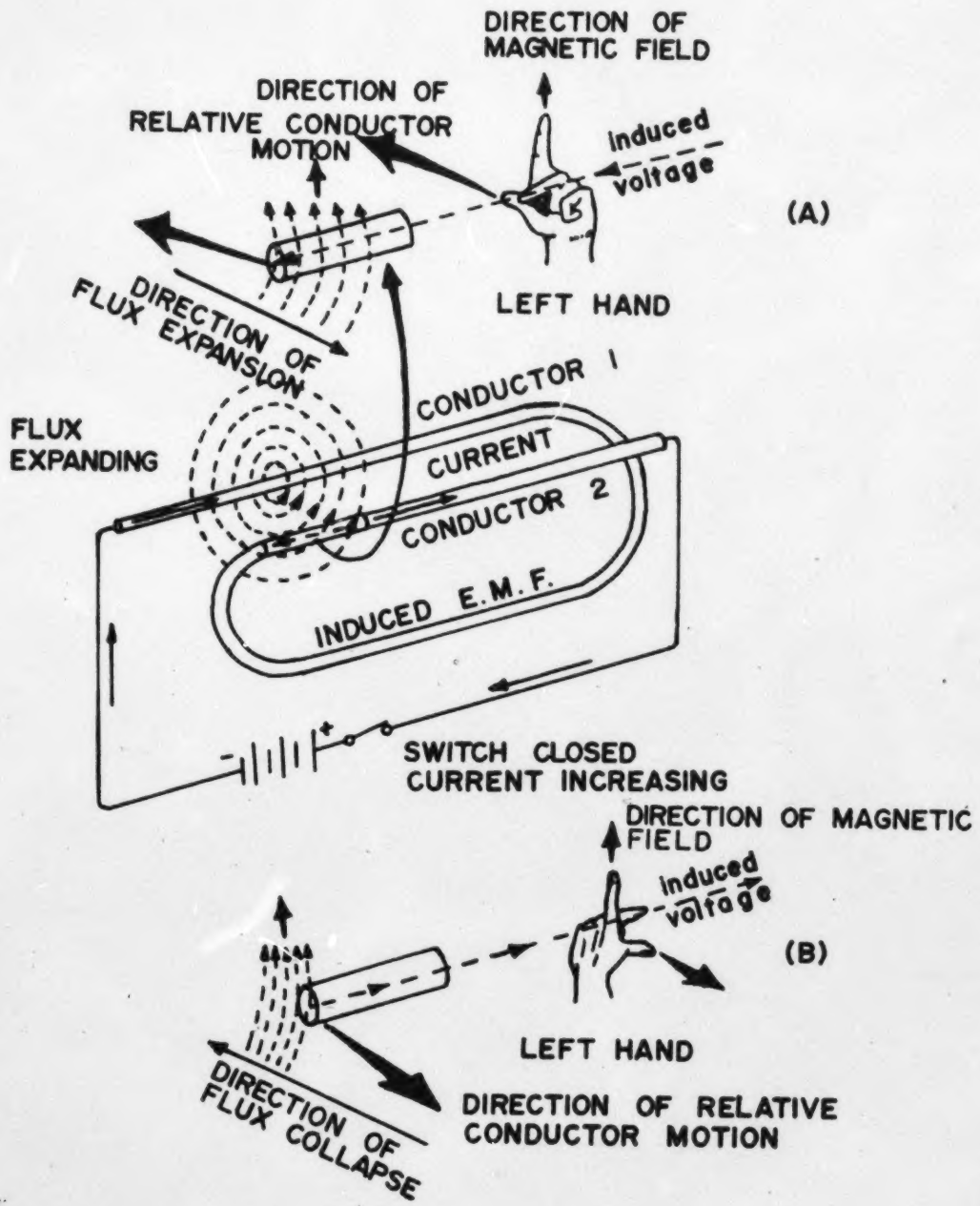
FOUR-POLE BASIC A C GENERATOR



RIGHT-HAND MOTOR RULE

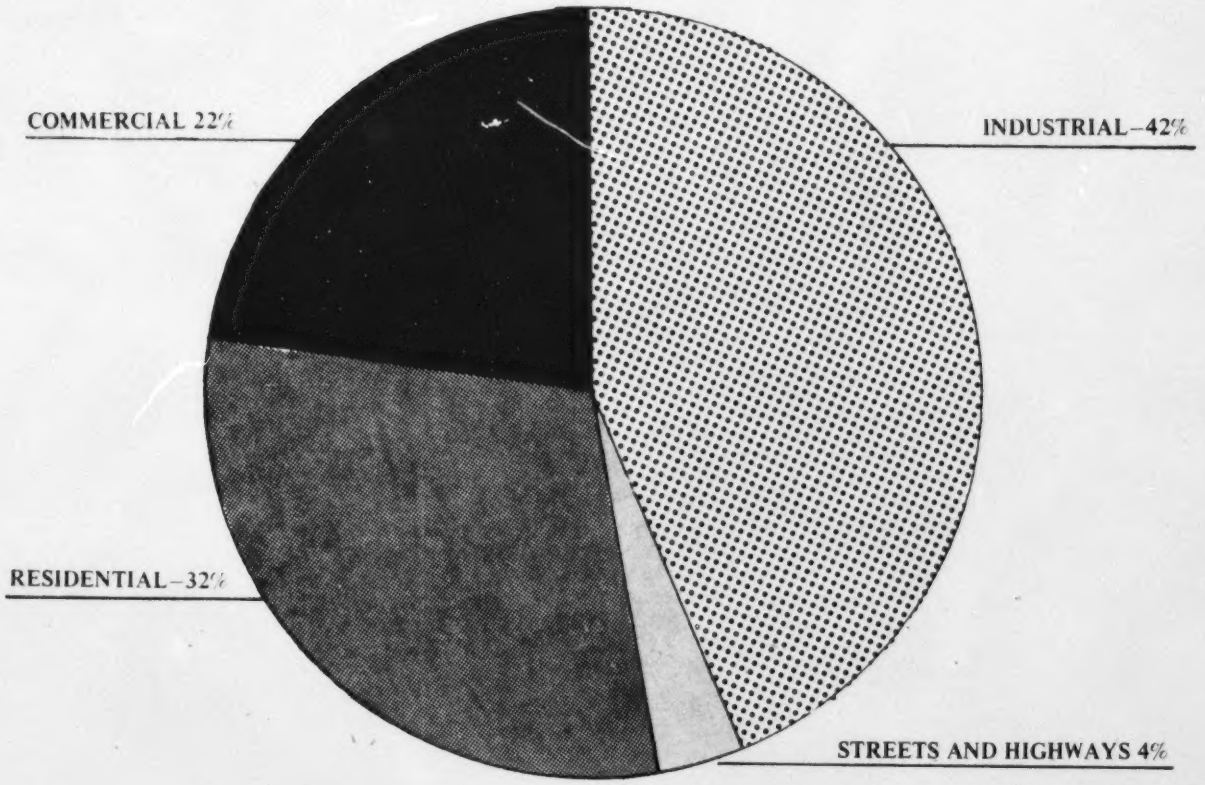
IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL

SELF - INDUCTANCE

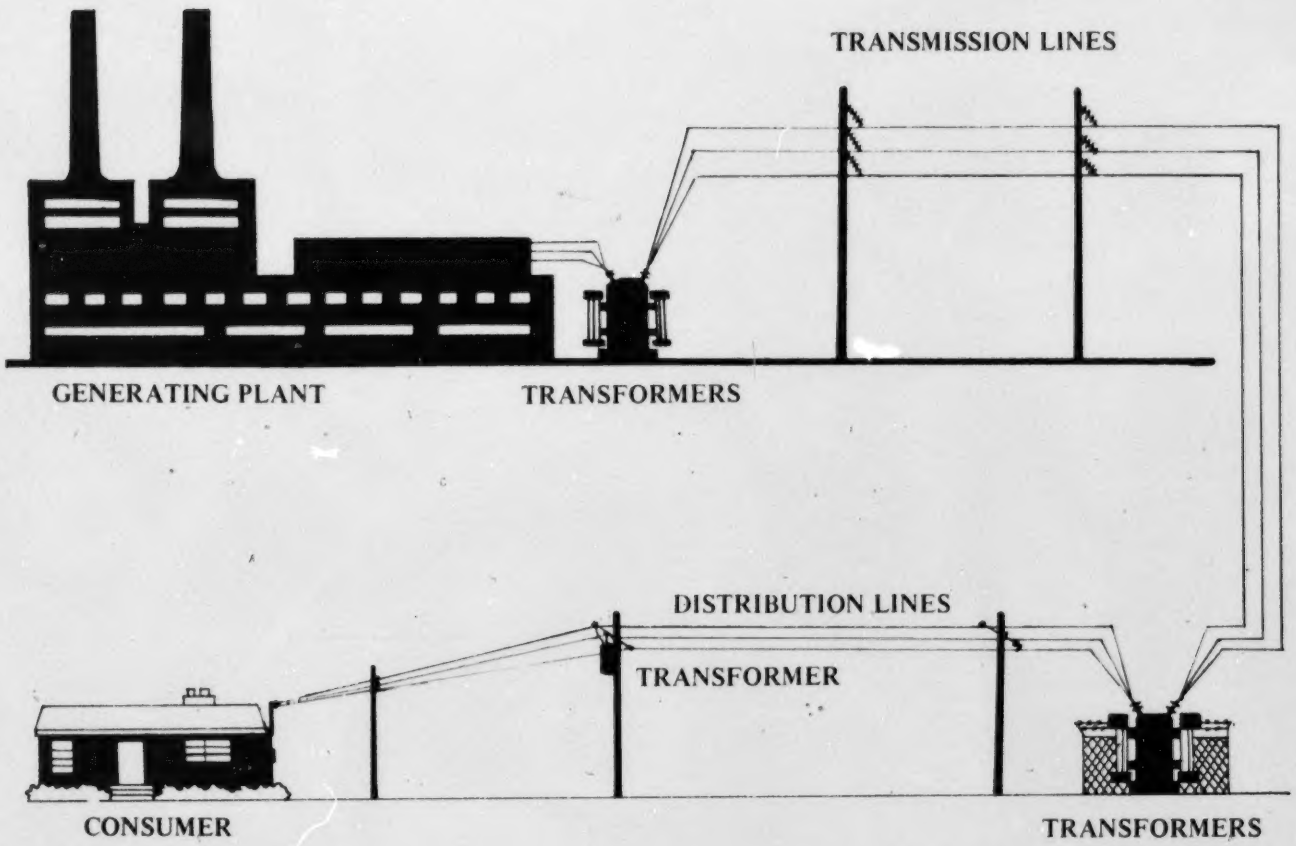


IML - UMC
COURTESY BUREAU OF NAVAL PERSONNEL

HOW ELECTRIC ENERGY IS USED

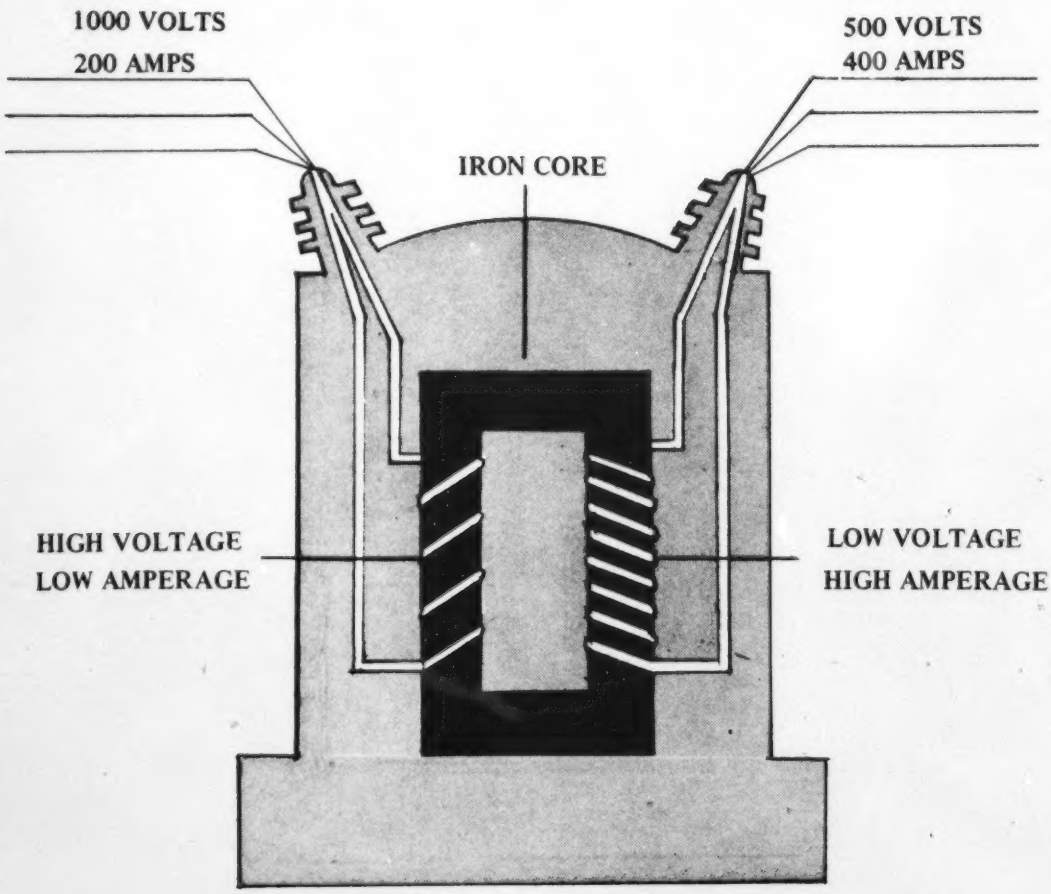


THE GENERATION AND TRANSMISSION OF ELECTRICITY

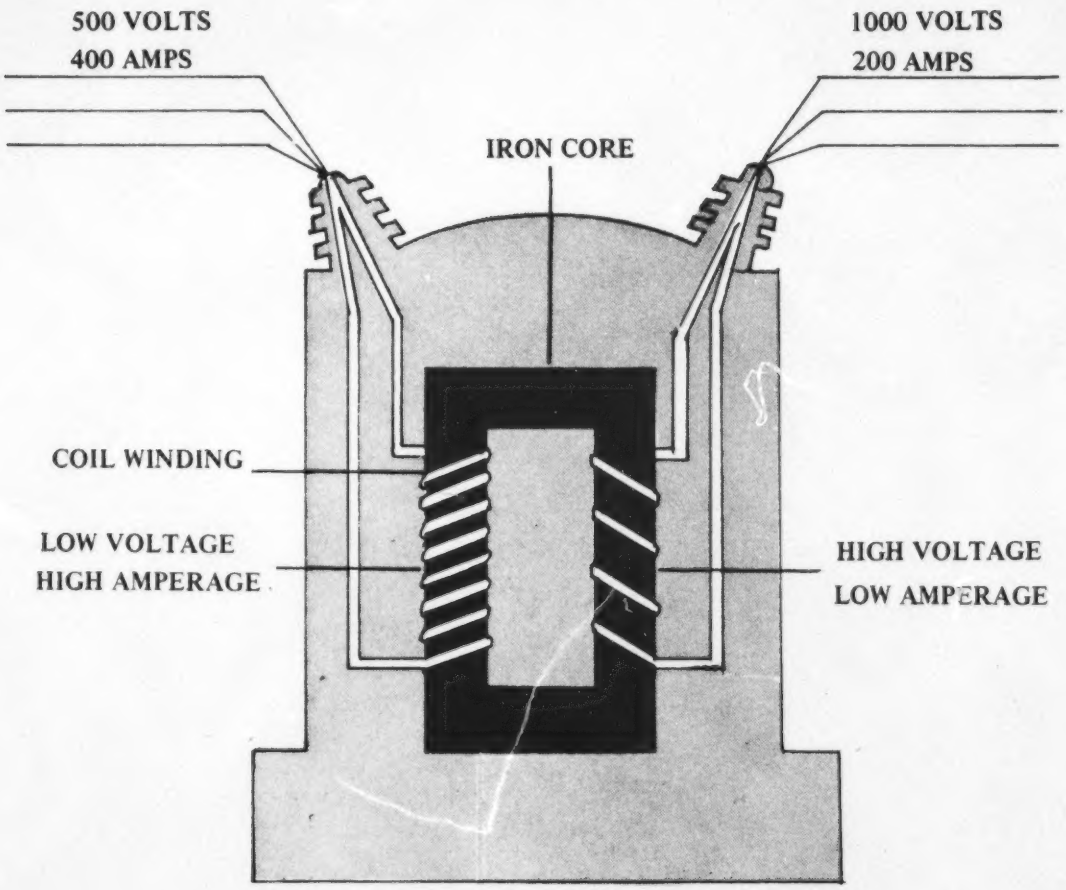


117

A STEP-DOWN TRANSFORMER



A STEP-UP TRANSFORMER



WATER POWERED GENERATOR